

Onan

**Service
Manual
LK
GenSets**

Important Safety Precautions

Read and observe these safety precautions when using or working on electric generators, engines and related equipment. Also read and follow the literature provided with the equipment.

Proper operation and maintenance are critical to performance and safety. Electricity, fuel, exhaust, moving parts and batteries present hazards that can cause severe personal injury or death.

FUEL, ENGINE OIL, AND FUMES ARE FLAMMABLE AND TOXIC

Fire, explosion, and personal injury can result from improper practices.

- Used engine oil, and benzene and lead, found in some gasoline, have been identified by government agencies as causing cancer or reproductive toxicity. When checking, draining or adding fuel or oil, do not ingest, breathe the fumes, or contact gasoline or used oil.
- Do not fill tanks with engine running. Do not smoke around the area. Wipe up oil or fuel spills. Do not leave rags in engine compartment or on equipment. Keep this and surrounding area clean.
- Inspect fuel system before each operation and periodically while running.
- Equip fuel supply with a positive fuel shutoff.
- Do not store or transport equipment with fuel in tank.
- Keep an ABC-rated fire extinguisher available near equipment and adjacent areas for use on all types of fires except alcohol.
- Unless provided with equipment or noted otherwise in installation manual, fuel lines must be copper or steel, secured, free of leaks and separated or shielded from electrical wiring.
- Use approved, non-conductive flexible fuel hose for fuel connections. Do not use copper tubing as a flexible connection. It will work-harden and break.

EXHAUST GAS IS DEADLY

- Engine exhaust contains carbon monoxide (CO), an odorless, invisible, poisonous gas. Learn the symptoms of CO poisoning.
- Never sleep in a vessel, vehicle, or room with a generator or engine running unless the area is equipped with an operating CO detector with an audible alarm.
- Each time the engine or genset is started, or at least every day, thoroughly inspect the exhaust system. Shut down the unit and repair leaks immediately.

- Warning: Engine exhaust is known to the State of California to cause cancer, birth defects and other reproductive harm.

Make sure exhaust is properly ventilated.

- Vessel bilge must have an operating power exhaust.
- Vehicle exhaust system must extend beyond vehicle perimeter and not near windows, doors or vents.
- Do not use engine or genset cooling air to heat an area.
- Do not operate engine/genset in enclosed area without ample fresh air ventilation.
- Expel exhaust away from enclosed, sheltered, or occupied areas.
- Make sure exhaust system components are securely fastened and not warped.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Do not remove any guards or covers with the equipment running.
- Keep hands, clothing, hair, and jewelry away from moving parts.
- Before performing any maintenance, disconnect battery (negative [-] cable first) to prevent accidental starting.
- Make sure fasteners and joints are secure. Tighten supports and clamps, keep guards in position over fans, drive belts, etc.
- If adjustments must be made while equipment is running, use extreme caution around hot manifolds and moving parts, etc. Wear safety glasses and protective clothing.

BATTERY GAS IS EXPLOSIVE

- Wear safety glasses and do not smoke while servicing batteries.
- Always disconnect battery negative (-) lead first and reconnect it last. Make sure you connect battery correctly. A direct short across battery terminals can cause an explosion. Do not smoke while servicing batteries. Hydrogen gas given off during charging is explosive.
- Do not disconnect or connect battery cables if fuel vapors are present. Ventilate the area thoroughly.

DO NOT OPERATE IN FLAMMABLE AND EXPLOSIVE ENVIRONMENTS

Flammable vapor can be ignited by equipment operation or cause a diesel engine to overspeed and become difficult to stop, resulting in possible fire, explosion, severe personal injury and death. **Do not operate diesel equipment where a flammable vapor environment can be created by fuel spill, leak, etc., unless equipped with an automatic safety device to block the air intake and stop the engine.**

HOT COOLANT CAN CAUSE SEVERE PERSONAL INJURY

- Hot coolant is under pressure. Do not loosen the coolant pressure cap while the engine is hot. Let the engine cool before opening the pressure cap.

ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Do not service control panel or engine with unit running. High voltages are present. Work that must be done while unit is running should be done only by qualified service personnel.
- Do not connect the generator set to the public utility or to any other electrical power system. Electrocution can occur at a remote site where line or equipment repairs are being made. An approved transfer switch must be used if more than one power source is connected.
- Disconnect starting battery (negative [-] cable first) before removing protective shields or touching electrical equipment. Use insulative mats placed on dry wood platforms. Do not wear jewelry, damp clothing or allow skin surface to be damp when handling electrical equipment.
- Use insulated tools. Do not tamper with interlocks.
- Follow all applicable state and local electrical codes. Have all electrical installations performed by a qualified licensed electrician. Tag open switches to avoid accidental closure.
- With transfer switches, keep cabinet closed and locked. Only authorized personnel should have cabinet or operational keys. Due to serious shock hazard from high voltages within cabinet, all service and adjustments must be performed by an electrician or authorized service representative.

If the cabinet must be opened for any reason:

1. Move genset operation switch or Stop/Auto/Handcrank switch (whichever applies) to Stop.
2. Disconnect genset batteries (negative [-] lead first).
3. Remove AC power to automatic transfer switch. If instructions require otherwise, use extreme caution due to shock hazard.

MEDIUM VOLTAGE GENERATOR SETS (601V TO 15kV)

- Medium voltage acts differently than low voltage. Special equipment and training are required to work on or around medium voltage equipment. Operation and maintenance must be done only by persons trained and qualified to work on such devices. Improper use or procedures will result in severe personal injury or death.
- Do not work on energized equipment. Unauthorized personnel must not be permitted near energized equipment. Induced voltage remains even after equipment is disconnected from the power source. Plan maintenance with authorized personnel so equipment can be de-energized and safely grounded.

GENERAL SAFETY PRECAUTIONS

- Do not work on equipment when mentally or physically fatigued or after consuming alcohol or drugs.
- Carefully follow all applicable local, state and federal codes.
- Never step on equipment (as when entering or leaving the engine compartment). It can stress and break unit components, possibly resulting in dangerous operating conditions from leaking fuel, leaking exhaust fumes, etc.
- Keep equipment and area clean. Oil, grease, dirt, or stowed gear can cause fire or damage equipment by restricting airflow.
- Equipment owners and operators are solely responsible for operating equipment safely. Contact your authorized Onan/Cummins dealer or distributor for more information.

KEEP THIS DOCUMENT NEAR EQUIPMENT FOR EASY REFERENCE.

ONAN
ELECTRIC GENERATING PLANTS
LK
SERIES

930-501

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GENERAL INFORMATION

INTRODUCTION

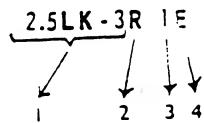
This manual contains all the information necessary for properly servicing LK electric generating plants. Unless otherwise stated, these instructions apply to all standard plants of the LK Series. For installation, preparation and operating instructions, refer to Operator's Manual.

Some details of these instructions may not apply to special models having modifications specified by the purchaser. Due to the wide variety of uses for which these plants are suitable, these instructions must be of a general nature. However, by using the instructions and recommendations given in this manual as a general guide, it will be possible to properly service the plant.

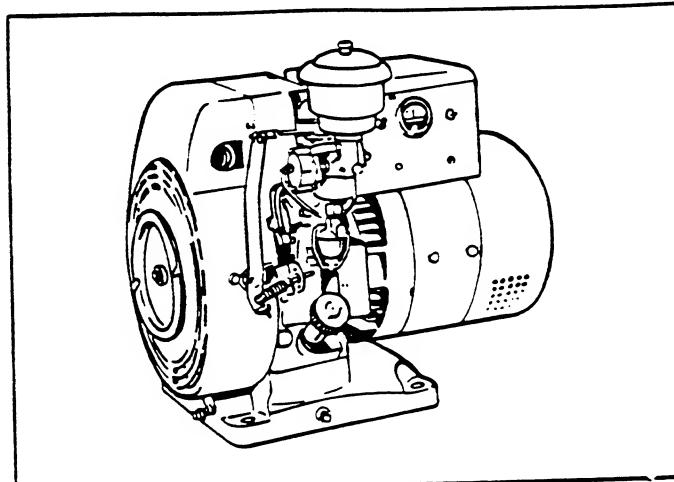
Instructions for 60-cycle plants apply also for 50-cycle except for current frequency and operating speed. The engine end is designated as the *front* end of the plant. *Left side* and *right side* of the plant are determined by viewing from the front end.

Instructions in this manual may refer to a specific model of generating plant. Identify the model by referring to the *MODEL AND SPECIFICATION NO.* as shown on the plant nameplate. Electrical characteristics are shown on the lower portion of the plant nameplate.

How to interpret MODEL and SPEC. NO.



1. Factory code for general identification.
2. Specific Type:
M - *MANUAL*. Manually cranked. For permanent or portable installations.
R - *REMOTE*. Electric starting. For permanent installation, can be connected to optional accessory equipment for remote or automatic control of starting and stopping.
3. Factory code for optional equipment.
4. Specification (Spec.) letter (advances when factory makes production modifications).



TYPICAL MODEL LK

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DESCRIPTION

GENERAL

Each LK generating plant is a complete electric power plant, consisting of an internal combustion engine, and a self excited electric generator, directly connected to the engine. Controls and accessories suitable for a normal installation and according to the particular model are supplied.

Each generating plant is given an actual running test at the factory and is carefully checked under various electrical load conditions before shipment, to assure that it is free of any defect and that it meets all performance requirements.

ENGINE DETAILS

- **TYPE:** Vertical 1-cylinder, L-head, 4-stroke cycle.
- **BORE:** 3-1/4"
- **STROKE:** 3"
- **DISPLACEMENT:** 24.9 cubic inches
- **HORSEPOWER:** 5.0 bhp at 1800 rpm
- **COMPRESSION RATIO:** 5.5 to 1
- **CYLINDER & CRANKCASE:** Integral, cast iron
- **MAIN BEARINGS:** Precision sleeve type, steel backed aluminum.
- **CAMSHAFT BEARINGS:** Precision sleeve type, babbit steel backed.
- **PISTON:** 3-ring, aluminum alloy, full floating type piston pin.
- **CONNECTING RODS:** Aluminum alloy, integral bearing.
- **LUBRICATION:** Positive splash system.
- **COOLING:** Air, pressure flow (Vacu-flow optional).
- **SPEED CONTROL:** Internal centrifugal flyball governor, external adjustments.
- **IGNITION:** Flywheel magneto (Manual), Battery Ignition (Remote) Shielded system.
- **FUEL:** Gasoline (gas optional).
- **VALVES:** Intake - carbon steel
Exhaust - austenitic steel with hard chrome cobalt alloy facing
Hardchrome - cobalt alloy seat insert, replaceable

CONTROLS

AC Manual and Portable Plants: These plants are started by manually cranking with a pull rope (carburetors are manually choked). Electrical load is connected to the plant by plugging into receptacles mounted on the plant. Plants are stopped by pushing a stop button on the plant blower housing. These plants can not be connected to batteries for electric starting.

AC Remote Control Plant: Remote control ac plants are designed for electrical starting. Remote control switches can be connected to provide for control of starting and stopping from convenient stations. Automatic (load demand) or load transfer (power failure) equipment can be connected for unattended control of starting and stopping. The remote control plant, using battery power for cranking, provides a battery charging circuit. Remote plants use an electrically choked carburetor.

AC Generators: Remote control models have an additional series winding which permits use of the generator as a motor for cranking the plant. The armature contains both ac and dc windings. Direct current is used for energizing the field, and is also used to charge the starting battery, on a remote control plant.

GENERATOR DETAILS (Basic Models)

- **TYPE:** Revolving armature, 4 pole, self-excited, inherently regulated. Drip-proof design. Permanently aligned to engine.
- **RATING:** 2500 watts ac, for continuous or standby service, at unity power factor, 60 cycle. ac generators incorporate engine cranking windings.
- **FREQUENCY REGULATION:** 3 cycles (5%).
- **BATTERY CHARGING:** Remote start models only 12 V. dc starting battery charging circuit with automatic 2 step voltage regulator. Max. charge rate - 8 amp.
- **COOLING:** Direct drive centrifugal blower. Air required 60 cfm.

SPECIFICATIONS

M = manual start

R = remote start (electric crank)

Model Series

2.5LK*

1.7LK*

M	R
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Nominal dimension of plant (inches)

Height	21	21
Width	18-5/16	18-5/16
Length	27-1/4	25

Number cylinders	1	1
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Displacement (cubic inch)	24.9	24.9
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Cylinder bore	3-1/4	3-1/4
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Piston stroke	3	3
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RPM (for 60-cycle)	1800	1800
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RPM (for 50-cycle)	1500	1500
--------------------------	------	------

Compression ratio	5.5	5.5
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Ignition (type)		
Flywheel magneto	Yes	No
Battery voltage (ac plant)	None	12-V

Battery size (ac plant):		
SAE group 1H		two 6-V in series
Amp/hr. SAE rating - 20-hr. (nominal)		105

Starting by pull rope (recoil) only	Yes	No
Starting by exciter cranking	No	Yes
Battery charge rate amperes		8-Max.

Ventilation Required (cfm 1800 rpm)		
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Engine	300	300
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Generator	60	60
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Combustion	20	20
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Output rated at unity power factor load	All	All
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Rating (output in watts)		
50-cycle ac continuous service	1700	1700
60-cycle ac continuous service	2500	2500

AC voltage regulation in $\pm\%$	6	6
--	---	---

AC frequency regulation in $\pm\%$	5	5
--	---	---

Revolving armature type generator	Yes	Yes
---	-----	-----

120/240-volt single-phase model reconnectible	No	No
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Rating - Utility Model (Formerly Spec 1330)		
	2500 watts ac (no dc load)	
	2110 watts ac (full dc load)	
	30 Amp dc (max) at 12 volts.	

OIL CAPACITY	4 pints
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AIR TEMPERATURE: Below 0°F	SAE 5W
0-30°F	SAE 5W-10W
30-90°F	SAE 30W
Above 90°F	SAE 50W

All oil used should carry API designation MS/DG or MS/DM.

* - New model designations shown began during 1969. Previous designations used a zero in place of the decimal point in the KW rating. EXAMPLE: 2.5LK was formerly 205LK and 1.7LK was formerly 107LK.

DIMENSIONS AND CLEARANCES

CLEARANCES (room temperature of 70° F.)

	Minimum	Maximum
Intake Valve Tappet Clearance at 70° F.	0.015"	0.017"
Exhaust Valve Tappet Clearance at 70° F.	0.015"	0.017"
Intake Valve Stem Clearance in Guide	0.001"	0.0025"
Exhaust Valve Stem Clearance in Guide	0.0025"	0.004"
Valve Seat Width	1/32"	3/64"
Valve FACE Angle	44°	
Valve SEAT Angle	45°	
Valve Interference Angle	1°	
Crankshaft Main Bearing Clearance	0.0025"	0.0038"
Crankshaft End Play	0.006"	0.012"
Camshaft Bearing Clearance	0.0015"	0.0030"
Camshaft End Play	0.003"	
Connecting Rod Bearing Clearance (Alum. Rod)	0.002"	0.003"
Connecting Rod End Play....	0.013"	0.038"
Timing Gear Backlash	0.002"	0.003"
Piston Clearance in cylinder, Conformatic Type (at bottom of skirt)	0.0005"	
Interference	0.0005"	0.0015"
Clearance		
Piston Pin Clearance in Piston at 70° F.		Thumb Push Fit
Piston Pin Clearance in Rod at 70° F.	0.0001"	0.0007"
Piston Ring Gap in Cylinder	0.010"	0.023"
Breaker Point Gap at Full Separation	0.020"	
Spark Plug Gap – For Gaseous Fuel	0.018"	
Spark Plug Gap – For Gasoline Fuel	0.025"	
Crankshaft Main Bearing Journal – Std. Size	1.9995"	2.000"
Crankshaft Rod Bearing Journal – Std. Size	1.6255"	1.6260"
Cylinder Bore – Standard Size	3.249"	3.250"
Anti-Flicker Point Gap (Prior to Spec. C)	0.020"	
Magneto Pole Shoe Air Gap	0.010"	0.015"

ASSEMBLY TORQUES

TORQUE (LB. FT.)

Cylinder Head Capscrews	27 to 29
Rear Bearing Plate Nuts	20 to 25
Connecting Rod Bolts	26 to 28
Flywheel Capscrew	40 to 45
Generator Thru-Stud and Nut	45 to 50
Armature Thru-Stud Nut	35 to 40
Gearcase Cover	15 to 20
Oil Base Mounting Screws	43 to 48
Spark Plug	25 to 30
Other 5/16 Inch Cylinder Block Studs and Nuts	10 to 12

ENGINE TROUBLESHOOTING

TROUBLE										CAUSE	
Backfire at Carburetor	Bearing Wear	Blue Exhaust	Burned Valves	Crank Slow or Weak	Failure to Start	High Oil Pressure	Loss of Coolant (Water Cooled)	Mechanical Knock	Overheating (Air Cooled)	GASOLINE ENGINE TROUBLESHOOTING GUIDE	
Blue Exhaust	Burned Valves	Crank Slow or Weak	Failure to Start	High Oil Pressure	Loss of Coolant (Water Cooled)	Mechanical Knock	Overheating (Air Cooled)	Piston Wear	Piston Compression		
Burned Valves	Crank Slow or Weak	Failure to Start	High Oil Pressure	Loss of Coolant (Water Cooled)	Mechanical Knock	Overheating (Air Cooled)	Piston Wear	Piston Compression	Ring Wear		
Crank Slow or Weak	Failure to Start	High Oil Pressure	Loss of Coolant (Water Cooled)	Mechanical Knock	Overheating (Air Cooled)	Piston Wear	Piston Compression	Ring Wear	Stuck Valves		
STARTING SYSTEM											
•	•									Loose or Corroded Battery Connection	
•	•									Low or Discharged Battery	
•	•									Faulty Starter	
										Faulty Start Solenoid	
IGNITION SYSTEM											
•	•	•	•	•	•	•				Ignition Timing Wrong	
							•	•		Wrong Spark Plug Gap	
			•	•		•	•			Worn Points or Improper Gap Setting	
						•				Bad Ignition Coil or Condenser	
						•				Faulty Spark Plug Wires	
FUEL SYSTEM											
			•	•						Out of Fuel - Check	
				•	•	•	•	•		Lean Fuel Mixture - Readjust	
•	•			•	•	•	•			Rich Fuel Mixture or Choke Stuck	
•	•			•	•					Engine Flooded	
•	•	•		•	•					Poor Quality Fuel	
•	•			•	•					Dirty Carburetor	
•	•	•	•	•	•	•	•	•		Dirty Air Cleaner	
•	•	•		•	•	•	•	•		Dirty Fuel Filter	
•	•	•		•	•	•	•	•		Defective Fuel Pump	
INTERNAL ENGINE											
	•		•	•	•	•	•	•	•	Wrong Valve Clearance	
	•			•	•	•	•	•	•	Broken Valve Spring	
	•	•		•		•	•	•	•	Valve or Valve Seal Leaking	
	•	•		•		•	•	•	•	Piston Rings Worn or Broken	
	•	•	•	•		•	•	•	•	Wrong Bearing Clearance	
COOLING SYSTEM (AIR COOLED)											
					•	•				Poor Air Circulation	
					•	•				Dirty or Oily Cooling Fins	
					•	•				Blown Head Gasket	
COOLING SYSTEM (WATER COOLED)											
						•				Insufficient Coolant	
						•	•			Faulty Thermostat	
						•	•			Worn Water Pump or Pump Seal	
						•	•			Water Passages Restricted	
						•	•			Defective Gaskets	
						•	•			Blown Head Gasket	
LUBRICATION SYSTEM											
				•	•					Defective Oil Gauge	
				•	•					Relief Valve Stuck	
•	•	•	•	•	•	•	•	•	•	Faulty Oil Pump	
•	•	•	•	•	•	•	•	•	•	Dirty Oil or Filter	
•	•	•	•	•	•	•	•	•	•	Oil Too Light or Diluted	
•	•	•	•	•	•	•	•	•	•	Oil Level Low	
•	•	•	•	•	•	•	•	•	•	Oil Too Heavy	
•	•	•	•	•	•	•	•	•	•	Dirty Crankcase Breather Valve	
THROTTLE AND GOVERNOR											
			•	•						Linkage Out of Adjustment	
			•	•						Linkage Worn or Disconnected	
			•	•						Governor Spring Sensitivity Too Great	
			•	•						Linkage Binding	

ADJUSTMENTS

ADJUSTMENTS

Satisfactory performance of the generating plant is dependent upon correct adjustments. However, adjustments cannot fully compensate for low engine power, neglect of periodic servicing, etc.

GOVERNOR

The governor controls the engine speed. On ac generating plants, engine speed determines generator output voltage and current frequency. By increasing engine speed, generator voltage and frequency is increased. An accurate voltmeter is required in adjusting the governor on ac plants. A small speed drop not noticeable without instruments will result in an objectionable voltage drop.

The governor arm is fastened to a shaft which extends from the gear cover, and is connected by a ball joint and link to the carburetor throttle arm. If the carburetor has been removed, or the governor disassembled, it may be necessary to re-adjust the governor.

A binding in the bearings of the shaft which extends from the gear cover, in the ball joint, or in the car-

buretor throttle assembly will cause slow governor action or poor regulation. Looseness or excessive wear in the governor mechanism will cause erratic governor action or an alternate increase and decrease in speed (hunting). A lean carburetor adjustment may also cause hunting. Springs of all kinds have a tendency to lose their calibrated tension through fatigue after long usage. If all governor and carburetor adjustments are properly made, and the governor action is still erratic, replacing the spring with a new one and resetting the adjustments will usually correct the trouble.

When the plant is stopped, tension of the governor spring should hold the carburetor throttle arm at the wide open position. At wide open position, the lever on the throttle shaft should just touch the carburetor body or clear it by no more than 1 '32". This setting can be obtained by increasing or decreasing the length of the connecting linkage as necessary by turning the ball joint on the threads of the link. Be sure to retighten the ball joint to the governor arm. This operation synchronizes governor action with carburetor throttle action.

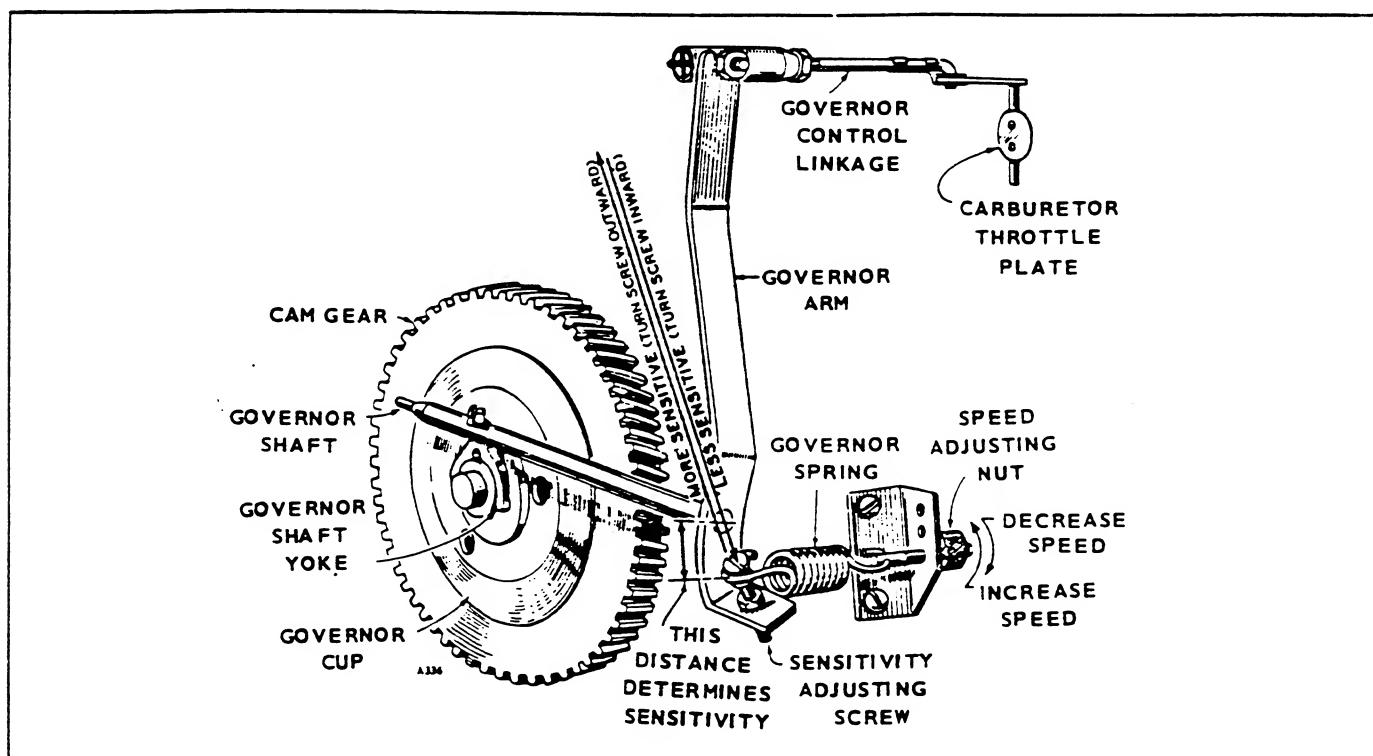


FIG. 1

Adjusting the Governor: Refer to Fig. 1. Connect a voltmeter across the output of the generator. With no electrical load connected, start the plant and adjust the speed adjusting nut to give a voltmeter reading of approximately 126-volts maximum for a 120-volt plant. Apply a full rated electrical load and again observe the voltage reading, which should be approximately 110-volts. For 240-volt plants, 252-volts at no-load is maximum and 220-volts full-load is minimum. The correct sensitivity adjustment gives the closest regulation without causing a hunting condition. If the voltage spread between no-load and full load conditions is too great, move the end of the governor spring closer to the governor shaft. Test the governor action at various load conditions. If voltage regulation is good, but there is a tendency toward hunting at times, the sensitivity adjustment is too close or sharp and the sensitivity stud must be turned inward slightly. Any change in the sensitivity adjustment will require a speed re-adjustment.

If a tachometer is used for adjusting the governor, engine speed at full-load for a 60-cycle plant should be approximately 1800-rpm for a 4-pole generator, with a spread of not more than 100-rpm between no-load and full-load. Engine speed at full-load for a 50-cycle plant should be approximately 1500-rpm for a 4-pole generator.

CARBURETOR

A small piece of foreign matter lodged in a jet may cause hard starting and poor operation. Dirty gasoline may cause the jets to wear larger, resulting in excessive gasoline consumption. Before tampering with jet settings, mark the existing adjustment or count the number of turns the needle was backed out from its seat.

The carburetor is a side (horizontal) draft type and has two adjusting needles (Fig. 2). The idle adjusting needle is located on the side nearer the cylinder head. The main jet (high speed) adjusting needle is located on the bottom of the carburetor begin Spec E and on the top on Spec's A-D. Turning a needle inward gives a leaner fuel mixture for that jet.

Full-load and no-load operating conditions are necessary when making carburetor adjustments. To obtain a full rated load condition, connect an ac load equal to the watt or ampere rating shown on the nameplate.

To obtain a no-load condition, disconnect all ac load, leaving starting batteries (where used) connected and with governor properly adjusted.

To adjust the carburetor, turn the adjusting needles in gently (finger tight) to their seats. Do not force them in, as they may be damaged by seating too tightly. Back the main needle out about 2-1/2 full turns. Back the idle needle out 3-1/4 of a turn. Start the plant and allow it to thoroughly warm up under a full-load condition.

Make the idle adjustment with no ac load connected to the generator. On the "utility truck" models the charge rate should be as low as possible. Use a frequency meter connected to the generator output (each cycle per second equals 30 rpm engine speed). Slowly turn the idle adjusting needle inward (clockwise) until the generator frequency (or engine speed) drops slightly below normal. Then turn the needle out until the frequency (or speed) returns to normal.

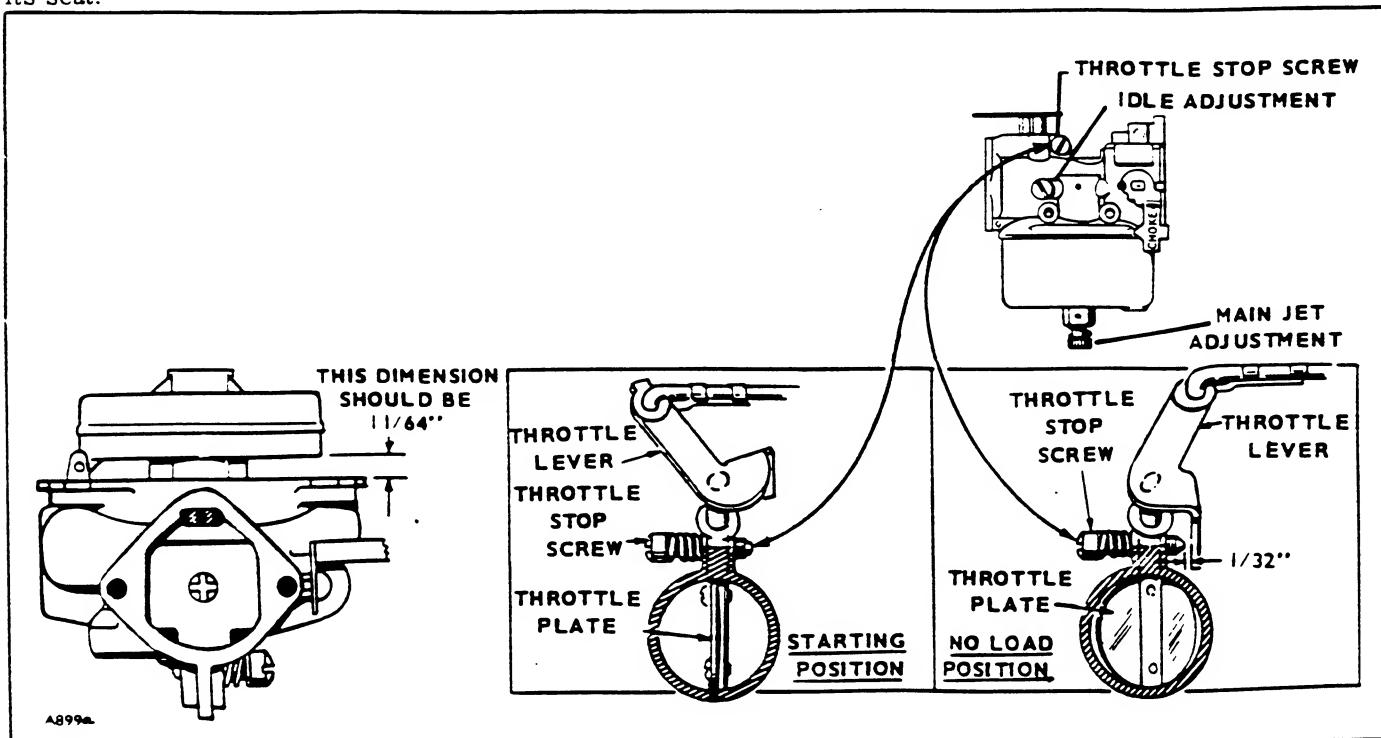


FIG. 2

To set the main jet adjustment, apply a full electrical load to the generator. Carefully turn the main adjusting screw inward (clockwise) until the generator frequency (or engine speed) drops slightly below normal. Then turn the needle out until the frequency (or speed) returns to normal. If there is a tendency to hunt (alternately increase and decrease speed) at any load, turn the adjusting needle out until the hunt is corrected. Do not turn the needle out more than 1/2 turn beyond the point where maximum generator output is obtained. Continuous unstable operation may be due to improper governor adjustment.

The throttle idle stop screw should be adjusted to clear the throttle shaft stop by 1/32" when the plant is operating at desired speed and no-load condition. This setting helps prevent hunting during changes in load.

CARBURETOR FOR GAS FUEL ONLY

To adjust the gas fuel carburetor, set the main adjusting screw approximately 1-1/2 turns open, and set the idle adjusting screw approximately 1-1/4 turns open, to permit starting the engine. (NOTE: Beginning Spec D, - no idle adjustment.) Follow the procedure given for gasoline carburetor in the preceding section to complete the adjustments.

The weighted carburetor choke (prior to Spec. E) should just close, but must be free to open with the air stream during operation. Some chokes are fitted with an adjusting screw - turn in for less choking action, turn out for more choking action.

GAS REGULATOR

The regulator was factory adjusted to lock-off at a pressure of 4 ounces (7" water column). It will operate satisfactory at incoming pressures between 2 and 4-ounces. If your gas supply pressure is within these limits, no regulator adjustment is required. If your gas supply pressure is under 2 ounces, the regulator will not operate. If your gas supply pressure is between 4 and 8 ounces, install an appliance regulator set for 2 ounces ahead of the regulator or adjust the regulator as follows:

Warning: A soap bubble placed over the regulator outlet will not accurately test the regulator lock-off. The soap bubbles resistance when multiplied by the greater area of the diaphragm, is enough to shut off this very sensitive demand type regulator. A manometer must be used to show complete regulator shut-off.

1. Use a manometer which reads up to 14" water column. (Note: 1-ounce per square inch equals 1.73" water column. Likewise 1" water column equals 0.58-ounces per square inch).
2. Remove 1/8" pipe plug (C) and connect manometer.

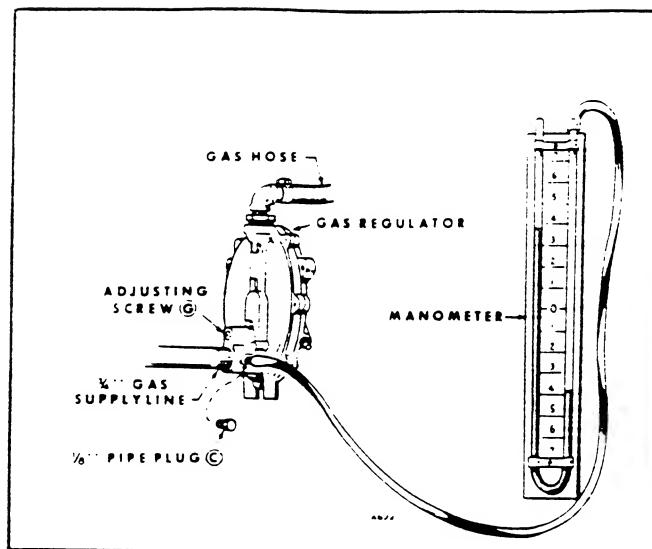


FIG. 3

3. With gas supply on and outlet hose removed, alternately cover and uncover the regulator outlet with your hand. If the regulator shuts off completely, as desired, the manometer will hold a steady reading. If the manometer reading drops slightly each time you remove your hand, the regulator is leaking.
4. When necessary, adjust as follows: Turn the adjusting screw (G) inward just far enough so that manometer reading remains constant when you repeatedly cover and uncover the regulator outlet with your hand.
5. Operate the engine to insure quick starting results.

ELECTRIC CHOKE

AC remote control plants are equipped with a thermal action electric choke. A thermostatic coil (bi-metal) engages the choke shaft and is set at the factory to give the correct choking action for average temperature conditions. When the plant starts, current from the generator is supplied to a small heating element in the choke cover. This heating element causes the thermal coil to wind tighter and turn the choke shaft, gradually opening the choke as the plant warms up. When the plant is stopped, the thermal coil cools off, causing the choke shaft to return to the correct position for the next start.

At a temperature of 70° F., the choke should be approximately 1 8" from the fully opened position. The thermal coil tends to coil tighter when heated.

Extreme temperature may require a slight adjustment of the choke setting. To adjust the choke, loosen the two screws which retain the choke cover to the body choke. For less choking action, turn the cover assembly slightly in a counter clockwise direction.

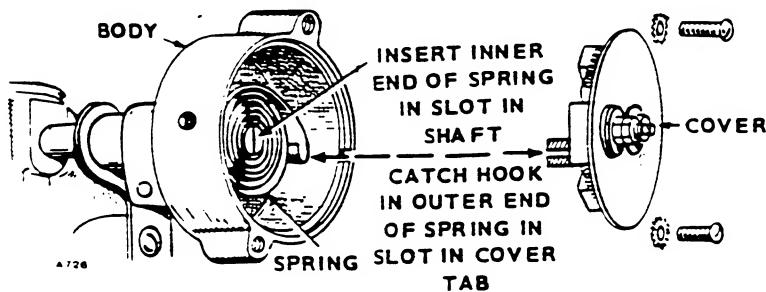
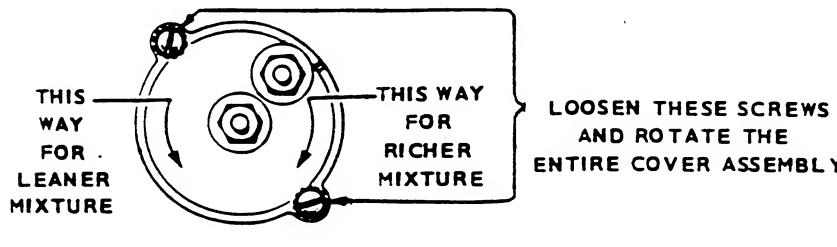
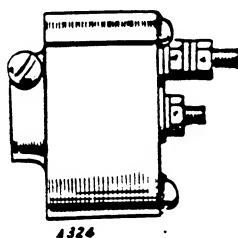


FIG. 4

If the choke does not operate properly, check to see that the heating element heats properly. There must be no binding of the choke shaft or thermal coil. Be sure to tighten the lock screw after any adjustment.

A manual operating lever and weight, fastened on the

opposite end of the choke shaft, may be used to operate the choke in the event the electric element burns out or the choke does not operate for any reason. Turn the lever to its horizontal position to open the choke. Choking position of the lever is vertical. However, choking position on manually choked plants is horizontal.

GENERAL MAINTENANCE

ENGINE MAINTENANCE AND REPAIR

CARBURETOR

Carburetor maintenance should consist of regular cleaning. Some gasolines have a tendency to form gum deposits inside the carburetor. This gum formation can usually be removed by soaking in alcohol or acetone. A fine soft wire may be used to clean jets.

Carburetor adjustments appear in the adjustment section. See that the float is not damaged. Be sure the throttle assembly works freely. When installing adjusting needles, do not force them into their seats. (See Fig. 2).

IGNITION SYSTEM

Proper ignition timing is accomplished by a breaker mechanism actuated by a cam on the camshaft. To test the spark, disconnect the cable from the spark plug and support it so that the end of the wire is $3/16''$ from a clean metal part of the engine. Crank the engine with the hand rope, observing the spark, which should jump the $3/16''$ gap with ease. If there is no spark, or a spark that is weak or yellowish in color, make repairs as necessary.

MAGNETO STATOR INSTALLATION

The stator is mounted behind the flywheel (Fig. 5). The stator has 2 pairs of mounting holes. Use the inside mounting holes for 19° spark advance. Connect the smaller coil lead (ground) to the stator mounting screw. Connect the larger coil lead to the ignition coil (either terminal). Be sure the larger lead is held in place to prevent rubbing on the flywheel. To expose the stator, remove the air housing and blower-wheel on Vacu Flo units or just the blower housing on pressure cooled units. Loosen the flywheel bolt a few turns. While pulling or prying outward on the flywheel, strike the flywheel bolt a sharp endwise blow to loosen the flywheel. Remove the flywheel bolt and carefully pull the flywheel off the crank-shaft.

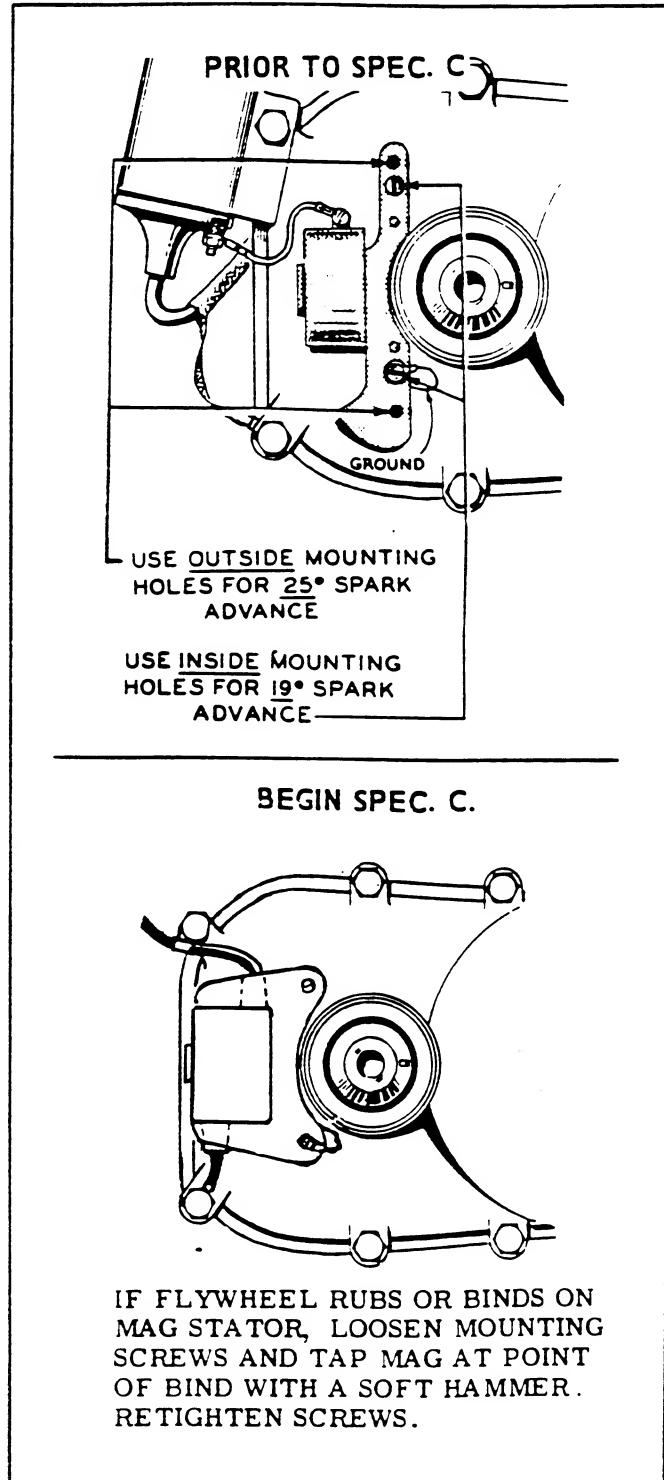
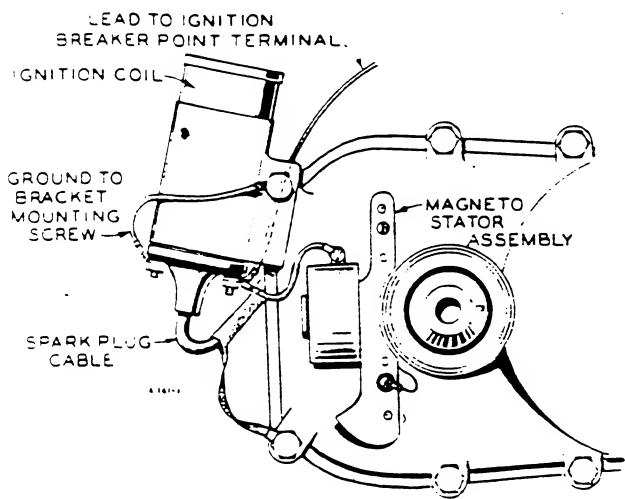
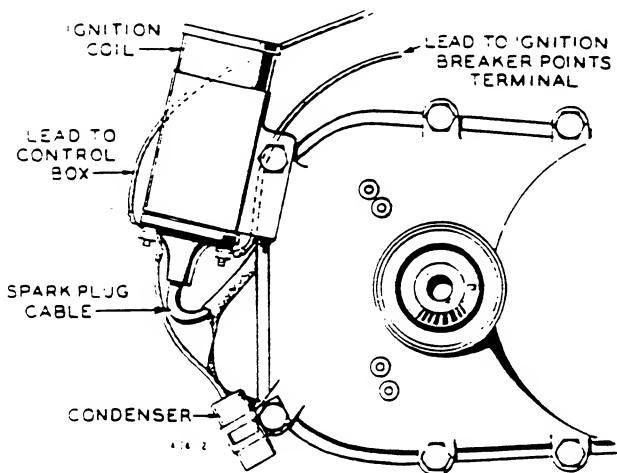


FIG. 5

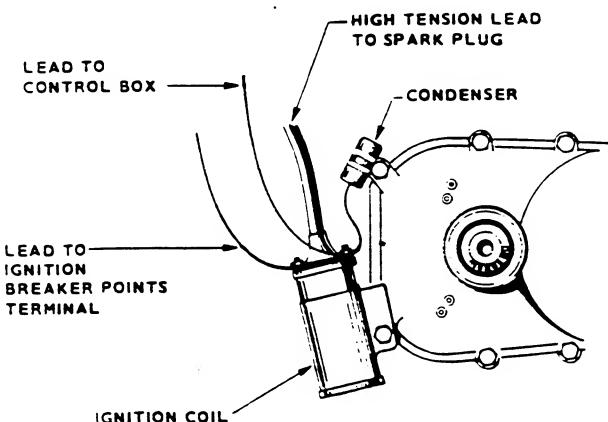
PRIOR TO SPEC. C
MAGNETO IGNITION
COIL INSTALLATION



TO SPEC. E
BATTERY IGNITION
COIL INSTALLATION



BEGIN SPEC. E



IGNITION COIL INSTALLATION

See Fig. 6 for coil connections for magneto ignition and battery ignition. The ignition coil is grounded on magneto ignition plants but not grounded with battery ignition. The spark occurs at the build-up of magneto current and at the collapse of battery current (magneto ignition coil used prior to Spec. C).

IGNITION TIMING

Ignition timing is the same for manual-start type plants with magneto ignition and remote-start type plants with 12-volt battery ignition (Fig. 7).

Replace burned or faulty points. If only slightly burned, dress smooth with file or fine stone. Measure gap with thickness gauge. Set gap at .020".

The spark advance is 19° before top center for all models. Set ignition timing as follows:

1. Remove breaker box cover.
2. Crank the engine over slowly by hand in the direction of crankshaft rotation until the painted witness mark on the flywheel and the "TC" mark on the gear cover are exactly in line ON THE COMPRESSION STROKE (Fig. 7).
3. Ignition breaker points (Fig. 7 & 8) must be correctly gapped. Crank engine to fully open breaker points (1/4 turn after top center). Loosen and move stationary contact to correct the gap at full separation. Tighten contact and check gap.
4. Turn the flywheel to the left, against crankshaft rotation, until the mark is about two inches past the 25° mark on the gear cover.
5. Turn the flywheel slowly to the right and note whether the ignition points just separate when the mark on the flywheel aligns with the 19° mark on the gear cover (engine must be on the compression stroke). If marks align as the points break, timing is correct. If not, loosen the breaker box mounting screws and shift the whole breaker box assembly slightly upward to retard the timing (points breaking too soon), or slightly downward to advance the timing (points not breaking soon enough). Tighten the breaker box mounting screws securely after making an adjustment.

To accurately check timing, use an automotive type timing light with engine running.

To check timing without running the engine, connect a continuity test lamp set across the ignition breaker points. Touch one test prod to the breaker box terminal (to which the lead to the coil is connected), and the other test prod to a good ground on the engine. Turn the crankshaft against rotation (backwards) until the points close. Then slowly turn the crankshaft with rotation (forward) until the points close. Then slowly turn the crankshaft with rotation. The lamp should go out just as the points break.

6. Install the breaker box cover.

FIG. 6

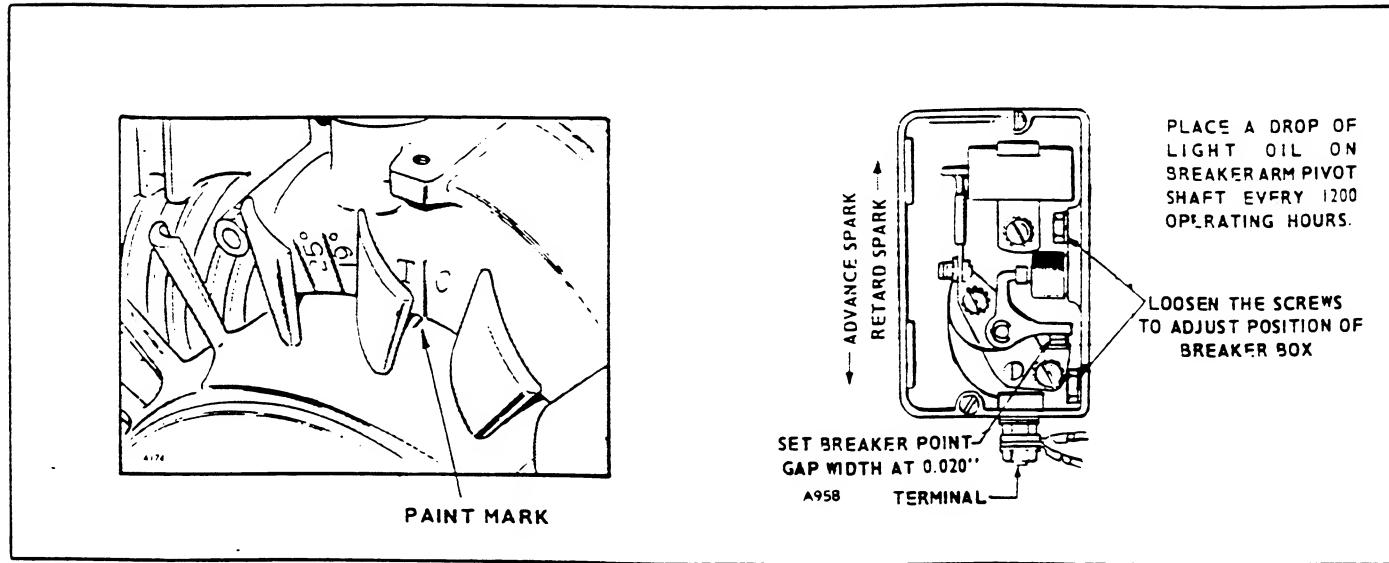


FIG. 7

ANTI-FLICKER MECHANISM

On all 1500 and 1800 rpm plants built prior to Spec. C and on some newer ones as an option, an anti-flicker mechanism is used. This mechanism compensates for the power surge during the power stroke of the engine. The breaker points, located on the right side of the crankcase just in front of the generator, are connected to the generator field resistor. A condenser connected across the breaker points prevents sparking and burning of the contacts.

VALVE SERVICE

Properly seating valves are essential to good engine performance. The aluminum cylinder head is removable for valve servicing. Do not use a pry to loosen the cylinder head, rap sharply on the edge with a soft faced hammer, taking care not to break any cooling fins. A conventional valve spring lifter may be used when removing the valve spring locks. Clean all carbon deposits from the cylinder head, piston top, valves, guides, etc. If a valve face is burned or warped, or the stem worn, install a new valve.

Worn valve stem guides may be replaced from inside the valve chamber. The gasket (Prior to Spec. C) must contact tightly against the upper valve chamber surface. Valve locks are the split, tapered type, the smaller diameter of which must face toward the valve head. Tappets are also replaceable from the valve chamber, after first removing the valve assemblies.

The valve FACE angle is 44° . The valve SEAT angle is 45° . This 1° interference angle results in a sharp seating surface between the valve and the top of the valve seat. The interference angle method of grinding valves minimizes face deposits and lengthens valve life. See Fig. 9.

Valves should not be hand lapped, if at all avoidable, since the sharp contact may be destroyed. This is especially important where stellite faced valves and

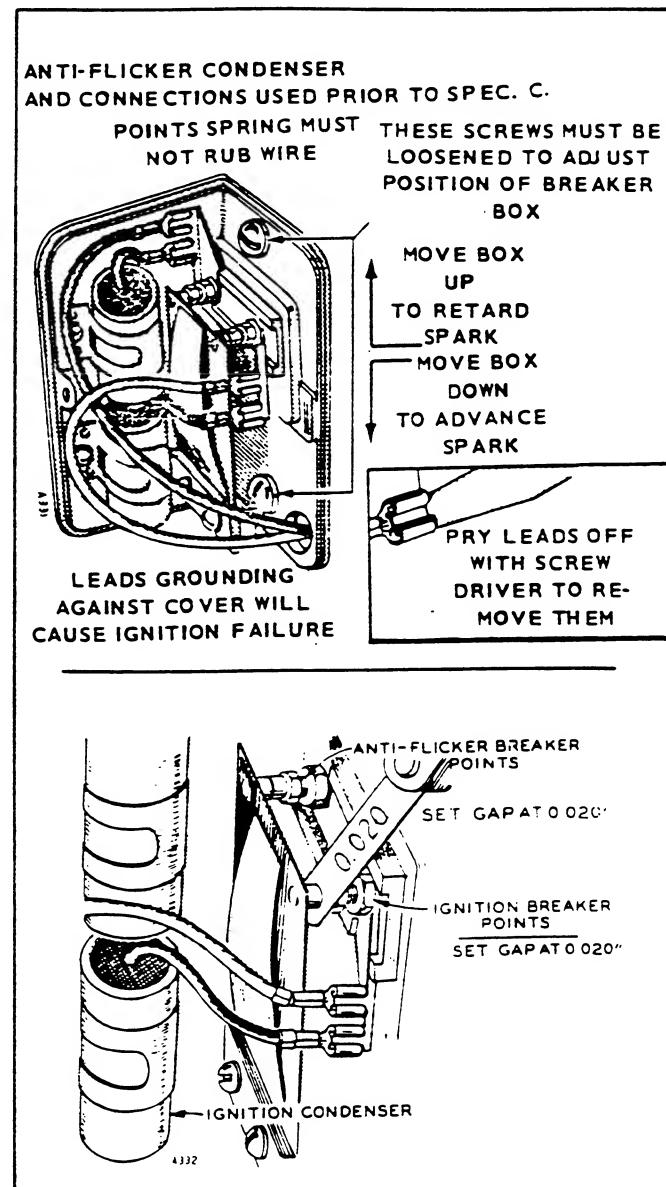


FIG. 8

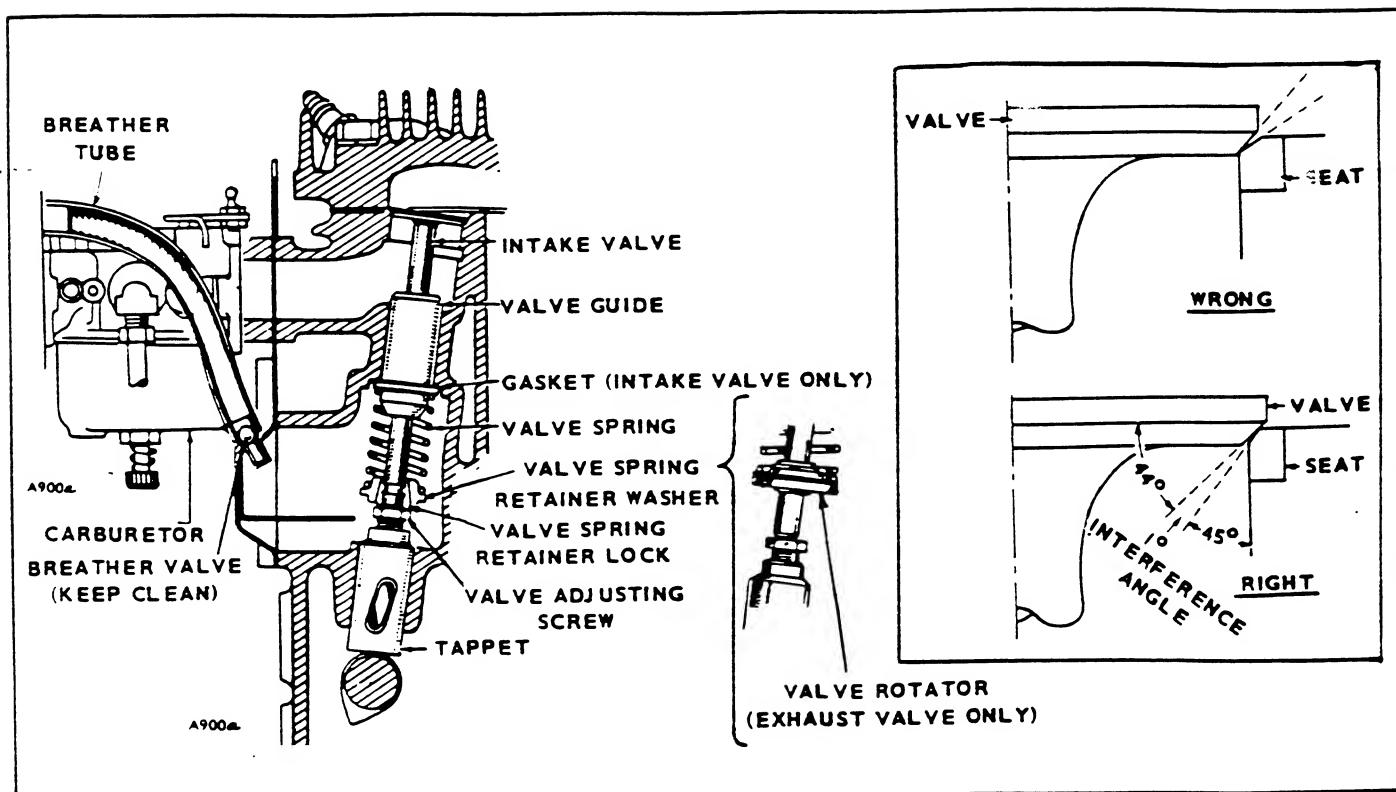


FIG. 9

seats are used. Valve faces should be finished in a machine to 44° . Valve seats should be ground with a 45° stone, and the width of the seat band should be $1/32$ to $3/64$ " wide. Grind only enough to assure proper seating.

Remove all grinding dust from engine parts and place each valve in its proper location. Check each valve for a tight seat, using an air pressure type testing tool. If such a tool is not available, make pencil marks at intervals across the valve face and observe if the marks rub off uniformly when the valve is rotated part of a turn against the seat.

Lightly oil the valve stems and assemble all parts removed. Adjust the valve tappet clearance.

TAPPET ADJUSTMENT

Tappet clearance may be easily checked after first removing the valve compartment cover and the blower housing. Crank the engine over by hand until the intake valve (the one nearest the carburetor) opens and closes. Continue turning the flywheel slowly until the mark on the flywheel is in alignment with the TC mark on the gear cover. The correct tappet clearance for both the intake and exhaust valves appears in the Table of Clearance. Tappets are fitted with self locking adjusting screws. Use a $7/16$ " wrench for the screw, and a $9/16$ " wrench for the tappet when making any adjustment.

GEAR COVER

When removing the gear cover, it is not necessary to remove the magneto assembly from the cover. Just disconnect the spark plug lead at the spark plug, and the stop wire.

When installing the gear cover, make sure the pin in the gear cover engages in the metal lined hole of the governor cup (Fig. 10). Turn the governor cup so that hole is in an upward position where it corresponds to the 12o'clock position on the face of a clock. Turn the governor arm and shaft clockwise as far as possible and hold in this position until the gear cover is installed flush against the crankcase. Be careful not to damage the gear cover oil seal.

GOVERNOR CUP

The governor cup may be removed from the cam gear and shaft after first removing the small lock ring from the camshaft center pin. Catch the governor flyballs as the cup assembly is removed.

If a new governor cup is being installed, the distance from the small lock ring on the center pin to the face of the governor cup must be exactly $7/32$ " when the cup is pressed back against the flyballs as far as possible. Fig. 11. If the distance is too small, carefully dress the face of the cup as required, being sure to remove any burr from the inside of the cup bore. If the distance is more than $7/32$ ", carefully

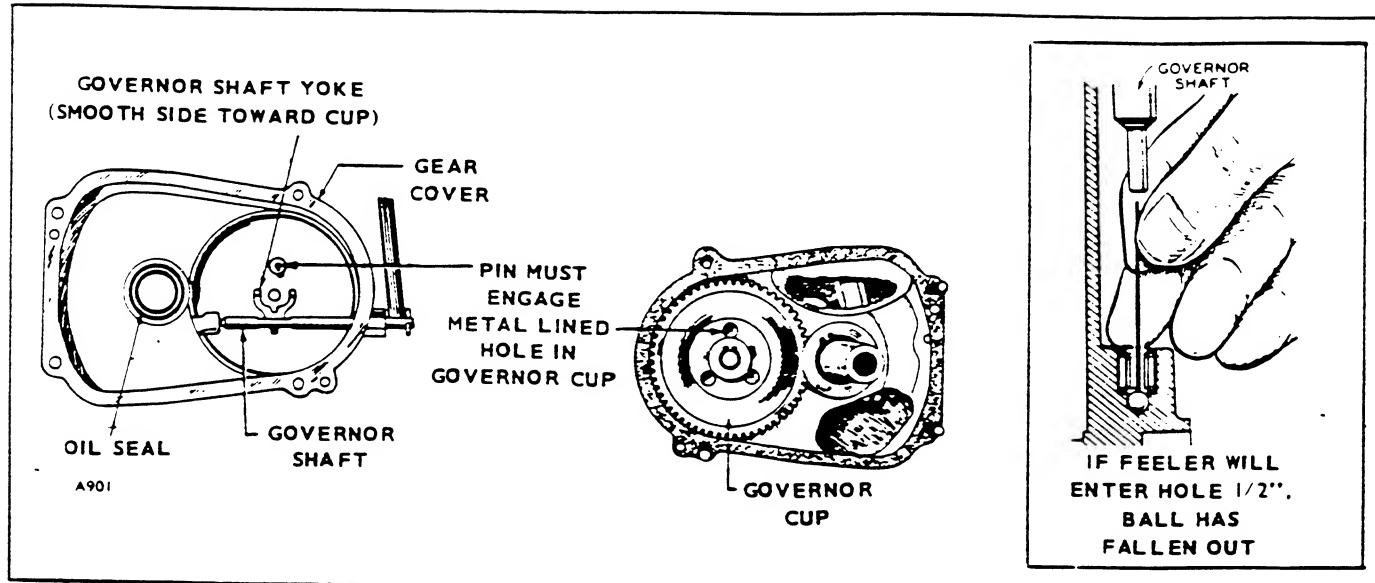


FIG. 10

press the pin in the required amount. Do not damage the pin, as it is difficult to replace it in the field. Replacement of governor flyballs is easier if the plant is tipped backward with the timing gears upward. Be sure that all flyballs are replaced and evenly spaced.

TIMING GEARS

If replacement of either the crankshaft or the cam-shaft gears becomes necessary, camshaft and gear must be removed as an assembly after first removing the crankshaft gear lock ring and washer. Before removing the camshaft and gear assembly, remove the cylinder head, valve assemblies, fuel pump, tappets and the anti-flicker breaker plunger (where used). After removing the governor cup assembly from the gear, the camshaft may be pressed out of the gear use of a hollow tool or pipe which will fit over the camshaft center pin. Do not press on or damage it in any way. The governor ball spacer is a press fit to the camshaft gear.

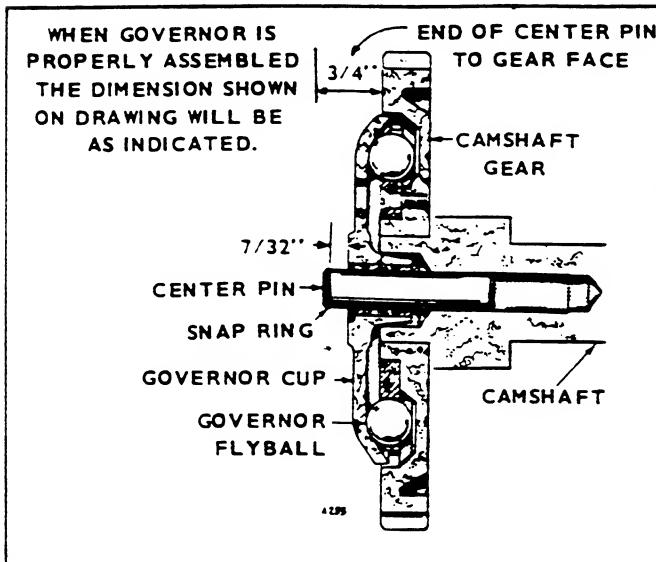


FIG. 11

When pressing a camshaft gear onto the camshaft, be sure the gear is started straight and that the key is properly in place. Install the governor cup assembly before installing the camshaft and gear in the engine.

Note that each timing gear is stamped with "O" mark near the edge. The gear teeth must mesh so that these marks exactly coincide when the gears are installed in the engine. Be sure, when installing the camshaft gear and shaft assembly, that the thrust washer is properly in place behind the camshaft gear. Replace the retaining washer and lock ring to the crankshaft.

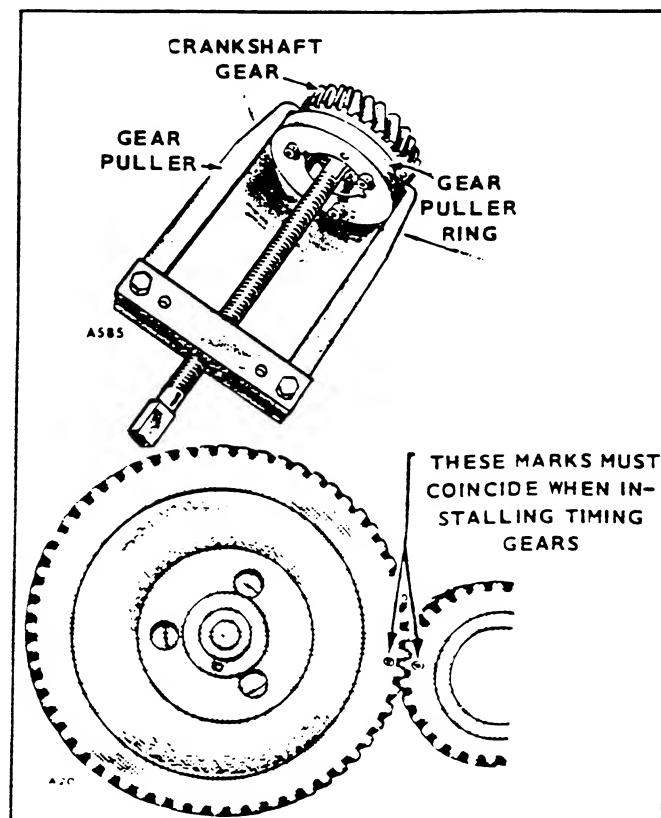


FIG. 12

CYLINDER

The cylinder wears very little in normal service. If through improper lubrication or accident, the cylinder wall should become scored or worn badly, the cylinder may be rebored and honed to accommodate a new piston and rings of one of the available oversizes. Pistons and rings are available in .010", .020", .030" and .040" oversizes. Some engines were fitted at the factory with a .005" oversize piston, and are so indicated by a letter "E" following the engine serial number stamped on the side of the crankcase, and on the nameplate. If the cylinder is not being reconditioned, but new piston rings are being installed, remove any ridge which may have formed at the top of piston ring travel in the cylinder bore. Use standard size rings on a .005" oversize piston.

PISTON AND RINGS

The piston and connecting rod assembly are removed through the top of the cylinder. The piston is fitted with two compression rings and one oil control ring. The piston ring grooves should be cleaned of any carbon deposits, and the oil return holes in the lower groove must be open. Before installing new rings on the piston, check the ring gap by placing each ring squarely in the cylinder at a position corresponding to the bottom of its travel (Fig. 13). The gap between

rings are to be used on .010", .020", .030", and .040" oversize pistons, respectively. Rings of the tapered type are usually marked "TOP" on one side, or identified in some other manner, and the ring must be installed with this mark toward the closed end of the piston. Space each ring gap one third of the way around the piston from the preceding one, with no gap directly in line with the piston pin. The bottom piston ring groove should be fitted with an oil control ring and the two upper grooves fitted with compression rings.

The piston is fitted with a full floating piston pin. The pin is kept in place by two lock rings in the piston, one at each side. Be sure these lock rings are properly in place before installing the piston and connecting rod in the engine. Correct piston to cylinder clearance appears in the Table of Clearance.

CONNECTING ROD

Mark the connecting rod before removing it to assure proper re-assembly. Note that the oil dipper is installed so as to splash oil towards the camshaft side of the engine (splash lubrication units only).

Connecting Rods are available in standard size or .010", .020", .030" undersize.

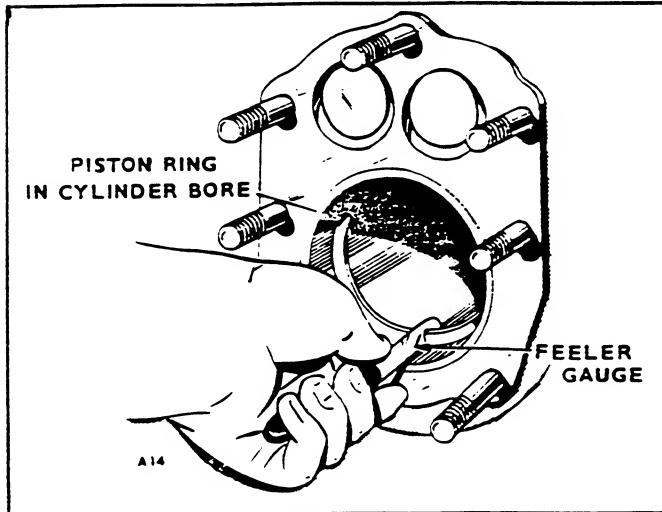


FIG. 13

the ends of the ring should be as given in the Table of Clearances. Rings which are slightly oversize may be filed as necessary to obtain the correct gap, but do not use rings which require too much filing. Standard size rings may be used on a .005" oversize piston. .010", .020", .030", and .040" oversize

The connecting rod and piston assembly must be properly aligned before assembly to the engine. Aligning should be done on an accurate aligning gauge by a competent operator. Misalignment may cause rapid wear of piston, pin, cylinder and connecting rod.

Be sure the connecting rod oil dipper is properly installed, as it is vital to proper lubrication (splash lubrication units only).

MAIN BEARINGS

Crankshaft main bearings are precision type and are available in standard size, .002", .010", .020", and .030" undersize. Precision type bearings DO NOT require line reaming.

Use a press or a suitable drive plug to remove bearings. Have the cylinder block supported to avoid distortion. Be careful not to damage the bearing bore, especially if a punch tool is used.

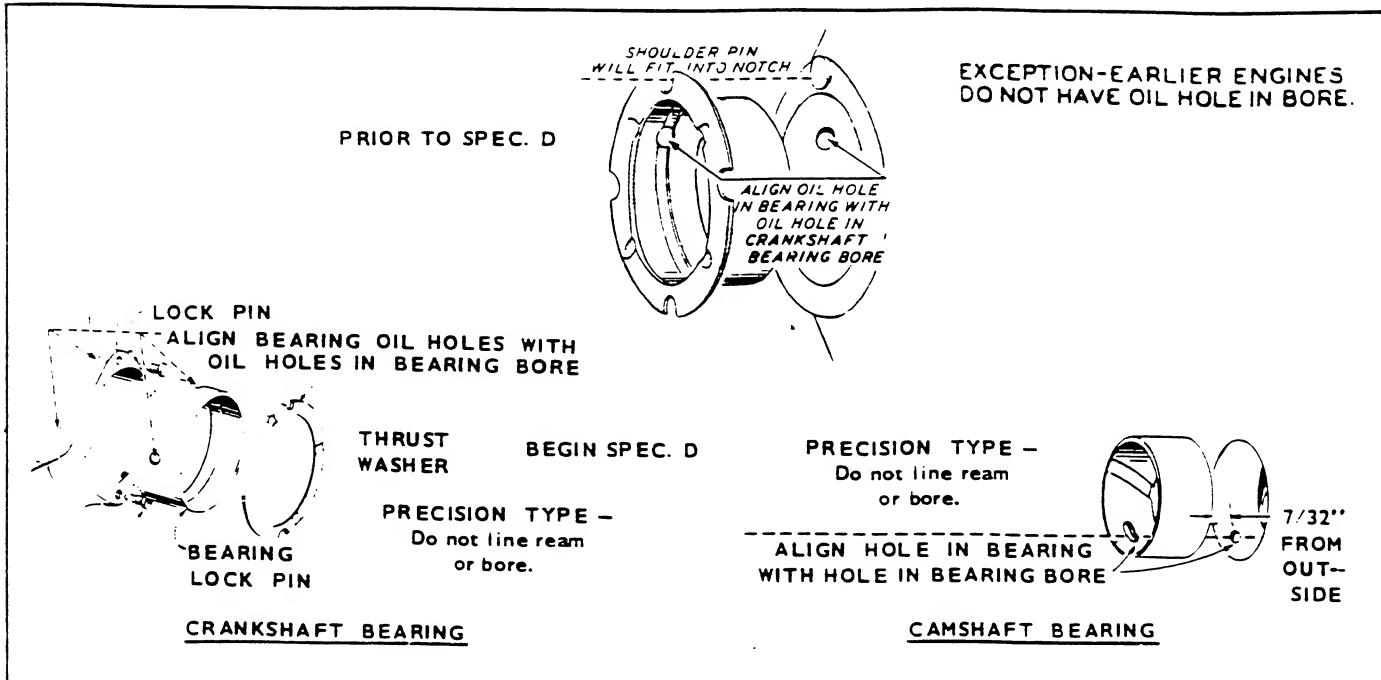


FIG. 14

Warm the bearing plate and cylinder block slightly with hot water or by placing in an oven heated to 200° F. In an emergency, a blow torch may be used, but only a little heat is required. Avoid over-heating.

Align the oil hole in the bearing and the oil passage hole in the bearing bore (Fig. 14). On splash lubricated units, the oil hole will be upward. Install the cold precision bearing so that the inside end of the main bearing is 1/16" to 3/32" back from the inside end of the bore to allow clearance for the machined radius of the crankshaft. If head of lock pin (used Begin Spec. D) is damaged, use side cutters or Easy-out tool to remove and install new pin. Apply oil to thrust washer to hold it in place while installing the crankshaft. Oil grooves in thrust washers must face the crankshaft, washers must be flat (not bent) and washers two notches must fit over two lock pins to prevent riding on crankshaft.

CAMSHAFT BEARINGS

Camshaft bearings are precision type and do not require line reaming. Press the front camshaft bearing in flush with the bottom of the counterbore which receives the expansion plug.

OIL SEALS

When replacing either crankshaft oil seal, (Fig. 15), be sure the open side faces toward the inside of the engine. Use care not to turn back the edge of the oil seal or damage it in any way. The rear bearing plate must be removed to replace the rear oil seal. Remove the gear cover to replace the front oil seal. Seal expanding and driving tools are available through the dealer.

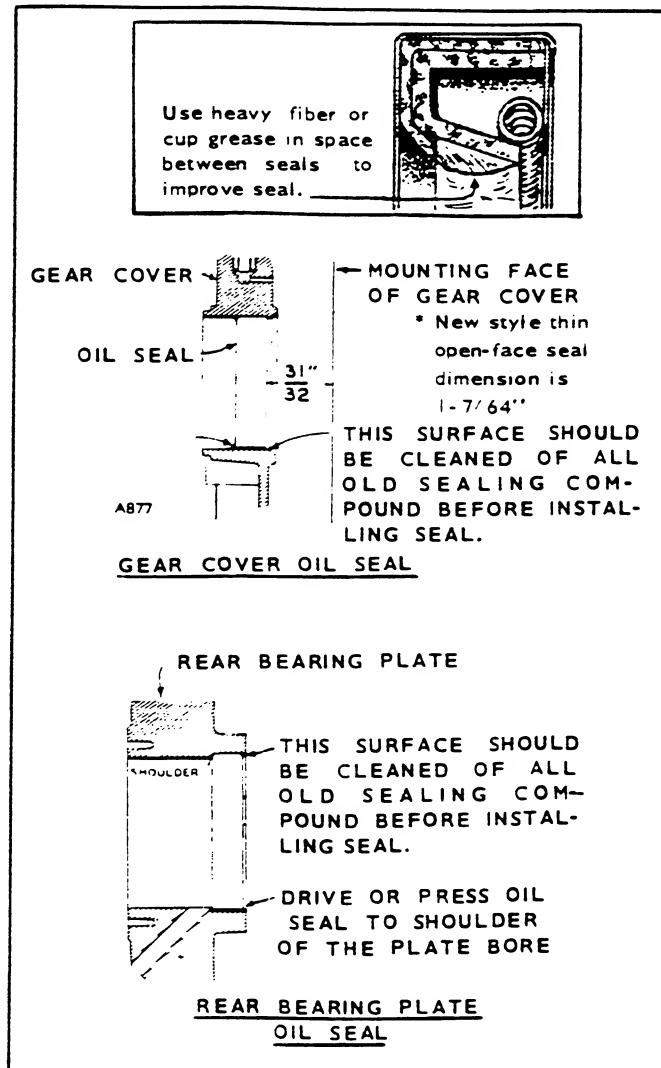


FIG. 15

When installing the gear cover oil seal, tap the seal inward until it is $31/32$ of an inch from the mounting face of the cover. Install new style, thin, open-face seal $1-7/64$ " from mounting face of cover.

When installing the bearing plate oil seal, tap the seal into the bearing plate bore to bottom against the shoulder in the plate bore. Use a seal expander or place a piece of shim stock around the end of the crankshaft. When replacing the bearing plate to avoid damaging the seal. Remove the shim stock as soon as the plate is in place.

Set crankshaft end play (Fig. 16) according to the Table of Clearances by using the correct thickness of gaskets between the rear bearing plate and the cylinder block. These gaskets must not block the oil passage on pressure lubricated units.

Before mounting generator to engine, tighten the rear bearing plate nuts. After securing generator to the engine, strike the flywheel screw sharply to re-adjust crankshaft forward end play (0.006 " to $0.012").$

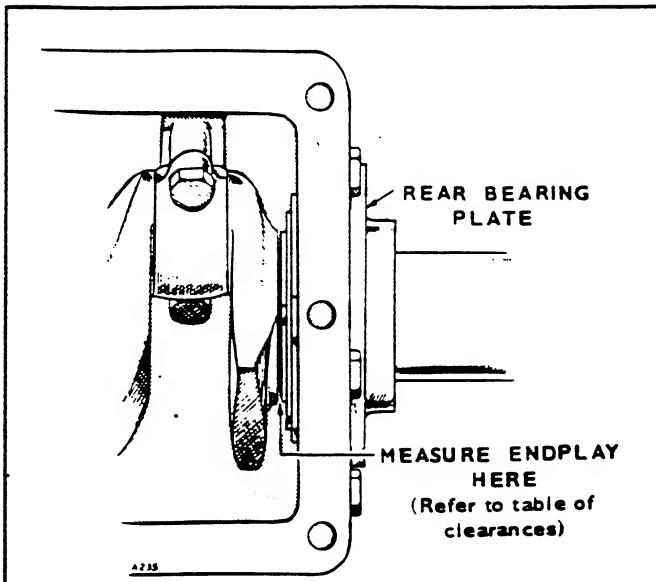


FIG. 16

VALVE COMPARTMENT OIL DRAIN

A drain hole from the valve compartment enters the crankcase. This hole must be unobstructed to provide for proper drainage of oil from the valve compartment.

AC GENERATOR MAINTENANCE

GENERAL

Generator construction used in this series has a 4-pole generator.

BRUSH REPLACEMENT

Install new commutator brushes and other rectangular brushes when the old ones are worn to $5/8''$ or less in length. The collector ring brush may be used until worn to $5/16''$ in length. It is not necessary to remove the brush rig to install new brushes. Remove the end cover to expose the brush rig. Brushes and leads are then easily accessible. New brushes are shaped to fit and seldom need sanding to seat properly. Always use the correct brush as listed in the parts list, never substitute a brush which may appear to be the same, but may have different electrical characteristics. Be sure to tighten the brush lead terminal nuts. If some brush sparking occurs after replacing brushes, run the plant at a light load until the brushes wear to a good seat.

BRUSH RIG POSITION

The position of the brush rig is important. The correct setting results in the least sparking at the commutator brushes at average load operation.

On standard models, the neutral brush rig position is determined and permanently fixed at the factory. It can not shift from neutral position.

Special models may have a brush rig of the adjustable design, where the neutral position is identified by a "witness" mark at the point of mounting. As long as the original brush rig and armature are continued in service, these reference marks must be observed. If a new brush rig or armature is installed, the original alignment marks may have to be disregarded in order to find the proper neutral position.

COMMUTATOR

Commutator and collector rings on ac plants, acquire a glossy brown finish in normal operation. Do not attempt to maintain a bright newly machined appearing surface. Ordinary cleaning with a dry, lint free cloth is usually sufficient. Very fine sandpaper (#00) may be used to remove slight roughness. Use only light pressure on the sandpaper, while the plant is operating. Do not use emery or carborundum paper or cloth. Clean out all carbon dust from the generator.

After long service, the surface of the commutator may become worn down to the level of the mica insulation between the commutator bars. This condition would lead to noisy brush action, excessive brush sparking and wear and pitting of the commutator bars. Undercut the mica between the bars to $1/32''$ below the surface of the bars. If it is not convenient to take the armature to an electrical shop, the operation may be done with a tool fashioned from a hack saw blade. Grind

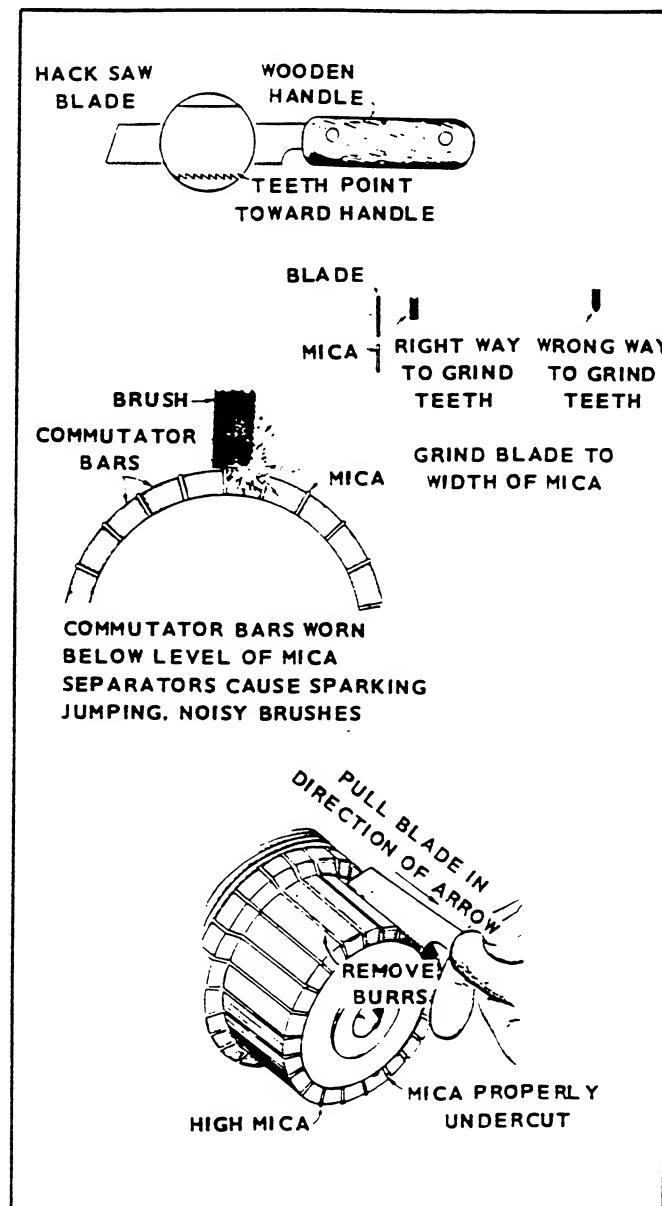


FIG. 17

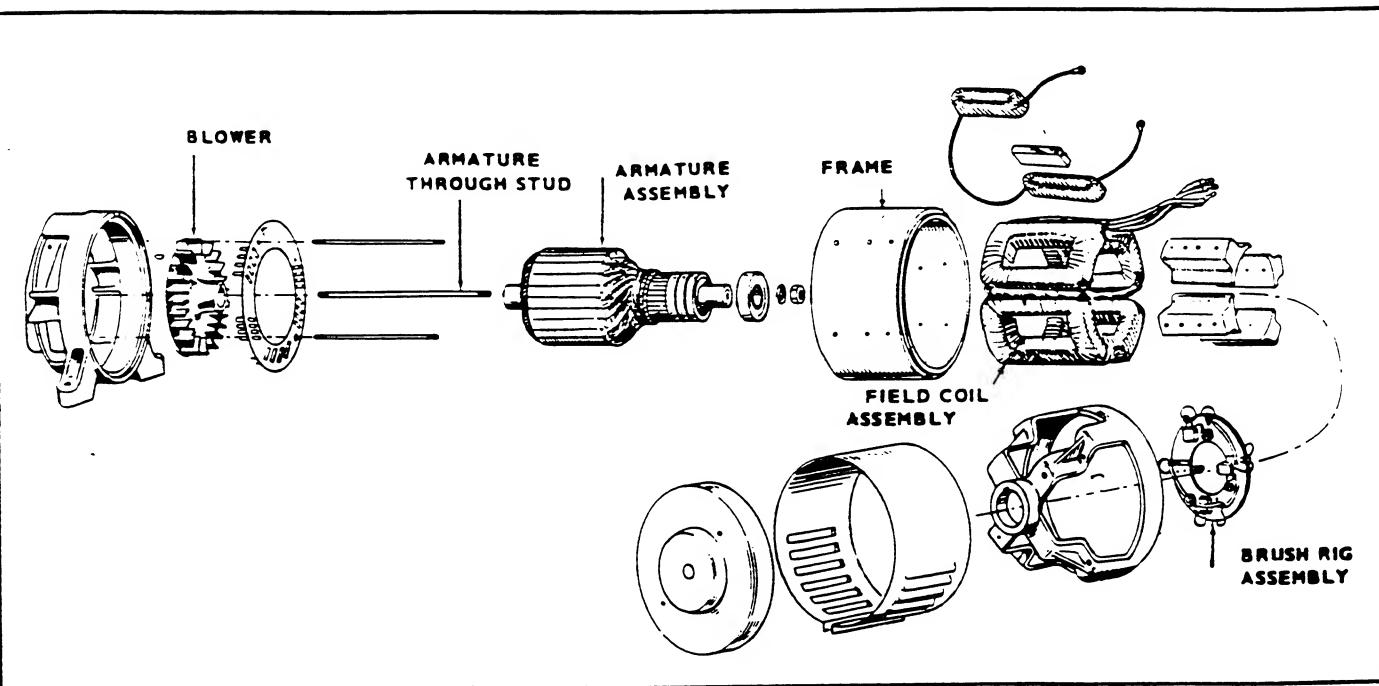


FIG. 18

the blade to a thickness equal to the mica between the bars. Do not scratch the surface of any bar. Use sandpaper to remove any burrs left along the edges of the bars. See that spaces between the bars are perfectly clean before assembling the generator.

If the commutator becomes damaged, or wears unevenly so that it is grooved or out of round, turn it smooth in a lathe. After turning, the mica must be undercut as described above.

GENERATOR DISASSEMBLY

To disassemble the generator, first remove the end cover. Lift each brush high in its guide, so that the brush is held by spring pressure against its side or remove the constant pressure type springs. It is not necessary to remove the brush rig from its support. Tag leads which are disconnected, to assure correct replacement. Mark the position of other parts by scratching them to aid correct replacement. After removing the two frame stud nuts, the brush rig and frame may be removed as a unit, the armature bearing remaining on the armature.

To remove the armature, loosen the armature center nut just enough to avoid damaging the threads. While pulling outward on the armature, strike the nut a sharp endwise blow with a heavy soft faced hammer, to loosen the armature. The armature has an external taper which fits into the internal taper of the engine crankshaft. When the armature is loose, remove the stud nut and slide the armature carefully off the through stud.

The frame will mount only in the correct side upward. If the brush rig has been removed, it must be installed in its original position. Avoid accidentally damaging brushes during assembly. Check for good brush contact and for good spring tension.

FIELD WINDINGS

A ground or open circuit in the field coils may be determined by using a continuity type test lamp. Disconnect (and tag) all field leads. Refer to the proper wiring diagram. Test the field winding for an open circuit by placing one test prod on each of the two terminal ends of the winding. If the test lamp does not light, the field winding is open. If the open circuit can be located in one of the external leads, the break can be easily repaired. An internal break usually requires replacement of the coil set. A grounded condition can be determined by placing one test prod on a bare metal part of the generator frame. If the test lamp lights, a ground is indicated. Find the point where the ground occurs and repair as necessary.

An internal short circuit is best located by the use of a sensitive ohmmeter. By comparing the resistance of

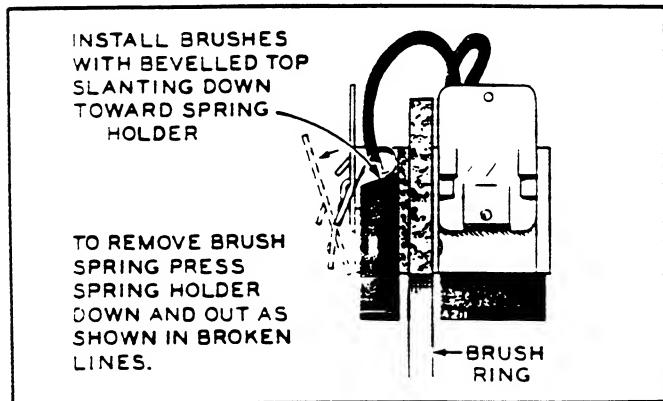


FIG. 19

STARTING SYSTEM

MANUAL STARTER

READI-PULL STARTER

Refer to Fig. 20 showing the Readi-Pull manual starter disassembled.

WARNING

The recoil spring may unwind and cause injury if let fly wildly when starter is disassembled or reassembled.

The sheave hub bearing (16) has recess which was packed full of grease at the factory. Normally, no additional lubrication is required. However, if the starter is disassembled for some other reason, add grease to the bearing and to the spring pawls (11) where they contact the ratchet arm (13).

To install a new rope or internal parts, remove the starter from its mounting ring by removing the four clamping screws.

To install a new rope, rotate the sheave (10) with crankshaft rotation direction to fully tighten the spring (8), back up only as necessary to align the hole in the sheave, with the slot in the cover (5), clamp the rope to the sheave, then when released, the rope will wind on the sheave.

To install a new recoil spring, remove the sheave from the cover. Wind the spring, with its rivet heads outward, forming a coil small enough to be inserted

in the recess of the starter cover. It may be necessary to tie the spring with a piece of wire to prevent its unwinding during installation unless other help is available. Place the spring in the cover recess in crankshaft rotation direction. Remove the tying wire if used. While holding the spring to prevent its unwinding, install the inside end of the spring on the roll pin (7) in the cover. With the pull rope removed, install the sheave assembly in the cover so that the tab on the sheave enters the outside end loop of the recoil spring. Be sure the thrust washer (9) is in place. Then install the pull rope.

Spring breakage is much less common than spring fatigue due to long usage. In either case, the spring should be replaced. Cleaning and lubricating the pawls, and ratchet arms in the rope sheave will improve a sluggish acting recoil. To temporarily extend the life of a fatigued spring, try rewinding it *inside out* (rivets heads inward).

To install a ratchet arm (13) in the sheave, the pawl (11), must first be removed. The ratchet arm will fit in only the correct position. The spring pawl must be installed with its flat edge against the ratchet arm.

The anti-back lash cogwheel (6) is an easy press fit on the starter cover.

1-ROPE AND GRIP	7-ROLL PIN	13-RATCHET ARM	19-WASHER
2-ROPE ONLY	8-RECOIL SPRING	14-PIVOT ROLL PIN	20-MOUNTING RING
3-GRIP ONLY	9-THRUST WASHER	15-ROPE CLAMP	21-SPEED GRIP NUT
4-PLUG	10-ROPE SHEAVE	16-BEARING	22-RATCHET WHEEL
5-STARTER COVER	11-PAWL	17-SCREW	23-RATCHET SPACER
6-COG WHEEL	12-PAWL SPRING	18-FLEXLOCK NUT	
6A-SPRING WASHER	12A-SPIROL PIN		

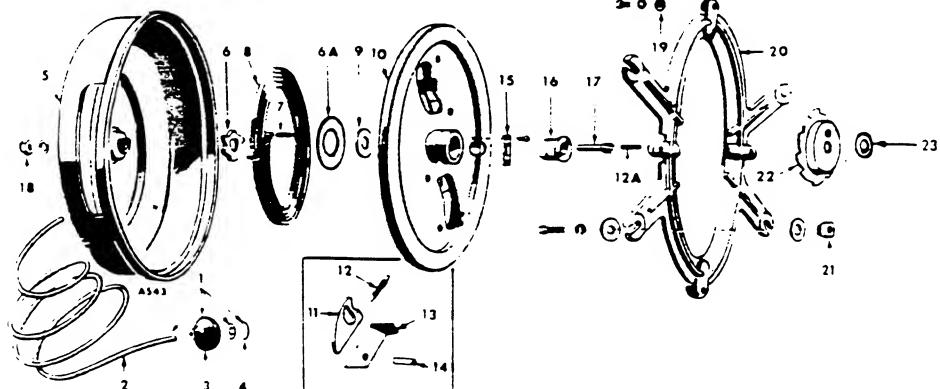


FIG. 20

each individual coil winding, a short circuited coil is indicated by a lower resistance reading. Replace the entire coil set assembly if a short circuit is indicated.

ARMATURE

Armatures may be tested for a ground by placing one test prod of a continuity type test lamp on the center shaft and the other test prod first on the commutator, then on one of the collector rings. If the test lamp lights, the armature is grounded. Place a test prod on each of the two collector rings. If the test lamp does not light, the ac winding is open circuited. The use

of an armature growler is required to test the dc winding for an open circuit, and to test for a short circuit. Follow the directions of the growler manufacturer.

CONTROL BOX EQUIPMENT

Always disconnect the battery from the plant whenever servicing any control box equipment. Keep all connections tight and clean, and inspect leads occasionally for worn insulation. If any of the control box equipment does not function properly, replace the defective part with a corresponding new unit. It is seldom practicable to repair relays, switches, etc.

6. The direction of pull on the starter rope is adjustable to fit the requirements of the individual installation. See detail B. To change the direction of pull, loosen the four clamp screws (8) and turn the starter in its mounting ring to the desired position. Tighten the four clamp screws securely. Try the starter several times, making sure that the pull rope will not rub against one of the clamp screws.

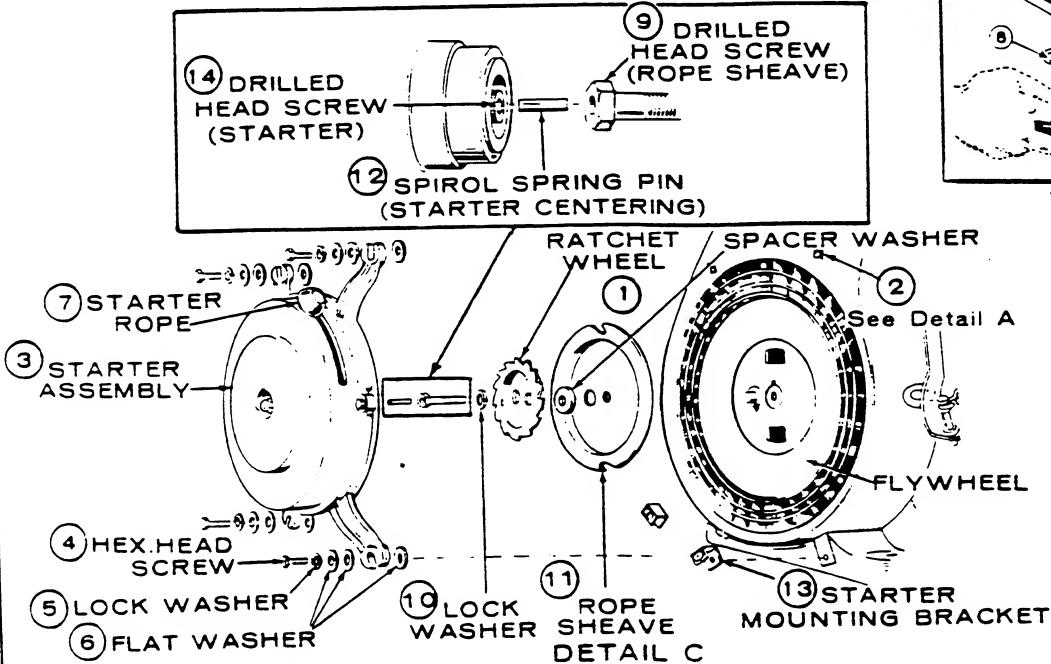
7. Occasionally check the operation of the starter, making sure the starter is properly centered (step 5 above). See that the blower housing mounting screws are tight. If the blower housing tends to shift, its mounting holes may have become worn oversize. If the blower housing tends to weave or distort during starter operation, installation of a new housing is recommended.

Units Beginning Spec B: See that the engine blower housing is in good condition. If the mounting holes are worn or if the blower housing is otherwise damaged replace it with a new one. Refer to Fig. 22.

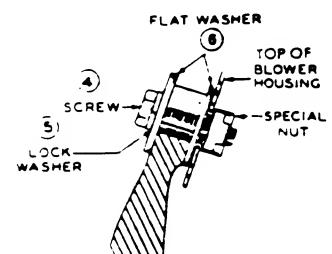
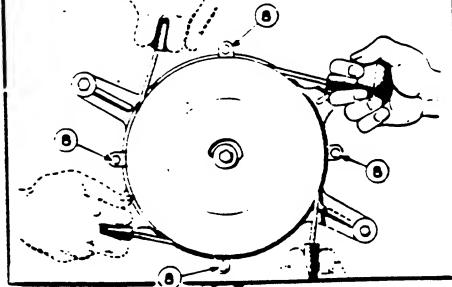
1. Install the new ratchet wheel (1) against rope sheave (12) using lock washer (11) and flywheel mounting screw (10). Discard the large flat washer from engine so equipped. Engage drive hole with flywheel boss.

2. Special nuts (2) are supplied for mounting the starter to the blower housing. If the blower housing is not already fitted with similar nuts, remove the blower housing and install the nuts as shown in detail A. Reinstall the blower housing, tightening securely in place.
3. Use the two bottom screws which hold the blower housing to the oil base to install the left- and right-hand starter mounting brackets (13 in detail B). Do not tighten at this time.
4. Install centering pin (12) in starter center screw (9) allowing $3/8$ " to protrude so it will engage with pilot hole in the flywheel mounting screw.
5. Center the starter assembly over the ratchet wheel with the centering pin (12) engaged. While holding in position, mount the starter using a hex head screw (4), lock washer (5) and two flat washers (6) at each mounting arm as shown in detail A. Note a thin flat washer is used under each arm and a thick washer outside the arm. Tighten the mounting screws securely.
6. Tighten the two lower screws on the blower housing removed earlier.
7. The direction of pull on the starter rope is adjustable to fit the individual installation. See detail B. To change the direction of pull, loosen the four clamp screws (8) and turn the starter in its mounting ring to the desired position. Tighten the four clamp screws securely. Try the starter several times, making sure that the pull rope will not rub against one of clamping screws.

UNITS BEGINNING SPEC "B"



DETAIL B
POSITION OF STARTER ASSEMBLY MAY BE CHANGED BY LOOSENING CLAMP SCREWS



DETAIL A

FIG. 22

INSTALLING THE STARTER

Units Prior to Spec B: Refer to Fig. 21. The blower housing on the engine must be as rigid as possible. Examine the blower housing carefully. If the mounting holes are worn or if the blower housing is otherwise damaged, replace it with a new one. Proceed as follows to install the complete starter kit:

1. Refer to the installation drawing. Do not change the flywheel mounting screw. New screws (if furnished) are needed on the other model engines only.
2. Install the new ratchet-wheel (1) to the blower wheel, using the two special head screws and lock washers provided. A 3/8" 12-point socket or closed end wrench fits these screws. Tighten securely.
3. Two special nuts are supplied for mounting the starter to the blower housing. If the blower housing is not already fitted with similar mounting nuts, remove the blower housing and install the nuts in the square holes (2) in the blower housing. See

detail A. Reinstall the blower housing, tightening securely in place.

4. Note that there are two small holes drilled through the starter cover. See detail C. Pull slowly out on the starter rope while sighting through one of these holes. When the starter is turned a partial turn, the open-center roll pins in the starter rope sheave will align with these two holes. While holding in aligned position, insert a ten penny common nail through each of the holes. Push the nails in up to their heads.
5. Install the starter assembly (3) to the blower housing, making sure that the nail ends enter the pilot holes in the ratchet wheel mounting screws. It will probably be necessary to turn the flywheel a partial revolution to allow proper alignment. While holding in position, mount the starter, using a hex head screw (4), lock washer (5), and two flat washers (6) at each mounting arm as shown in the detail drawing A. Tighten the mounting screws securely. Remove the nails.

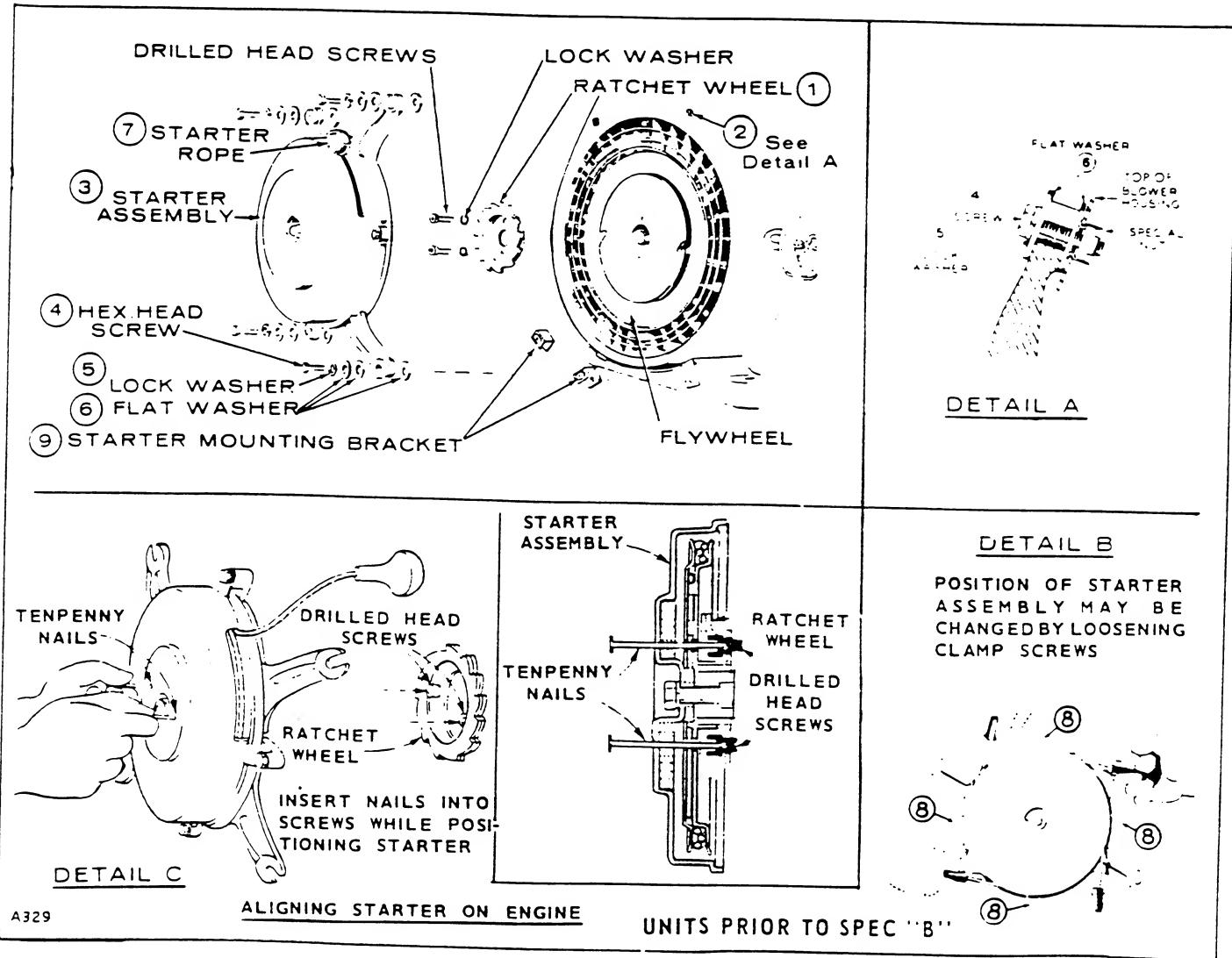


FIG. 21

AC OVER-LOADING

It is not expected that men on the job will determine available load each time before plugging in tools, etc. Over-loading is apt to occur especially during night work when both lights and tools are used. If the plant speed drops, ac lights will dim, and part of the load must be disconnected. If more ac power is required, simply run the truck's motor to take over the dc load for that interval, and make the full rating available in ac output.

A short circuit across the ac terminals will collapse the field to protect the generator.

GOVERNOR ADJUSTMENT

To check or correct the engine speed, a dc voltmeter is required. the plant must be warm and all load disconnected. Proceed as follows:

1. Run plant with full ac load connected for at least 1/2-hour to reach operating temperature.
2. With the load alternately removed and connected, adjust the governor sensitivity screw, if necessary, to attain a minimum drop in speed from no-load to full-load operating with no hunting condition.
3. Remove the ac load and stop the plant, then disconnect the generator lead A1 at the diode in the plant control.
4. Connect the dc voltmeter across lead A1 and ground.
5. Run the plant and adjust the speed to deliver 15 volts dc.
6. Remove the voltmeter, reconnect the A1 lead to the diode and replace other parts removed.

SPECIAL UTILITY SECTION

This section applies specifically to the "Utility Truck" models of the LK series generating plants. These supplementary instructions are to be used, where they apply, instead of the instructions for the standard generating plants.

For instructions not covered in this section, refer to the appropriate section for the standard plants.

The utility plant is designed to supply 12-volt dc output for radio etc., while the truck is stopped at a service job. At the same time, ac power is available for flood lights, power tools, etc. Thus, the generating plant eliminates the necessity of running the truck engine to prevent battery run down at a service job. The generating plant can also be used to recharge a low truck battery if ac power requirements are sufficiently reduced. In normal operation, the plant supplies dc and ac current for the load, but does not recharge the battery.

The utility plant has a relay, which opens the charging circuit in the generator set when the truck engine is running, to prevent the battery from being charged from both sources at the same time. This is necessary to prevent damage to the reverse current relay in the truck and or generator set charging systems as a result of interaction between them. A silicon diode is used in place of a reverse current relay, begin Spec K.

RATED OUTPUT

(Alternating current and direct current are produced at the same time.)

• Combined AC and DC rated output	2,500 Watts
• Maximum DC amperes (automatically limited)	30 Amps
• Maximum DC watts (maximum 30 amps x nominal 13 volts)	390 Watts
• Available AC output (2500 watts less watts of DC charging current)	
Minimum (while full load dc connected - truck stopped)	2110 Watts
Maximum (while truck running or battery charged and no DC load connected) ..	2,500 Watts
• Open circuit DC voltage (12-volt battery charging)	15 Volts
• Nominal AC voltage (power for tools, etc.)	120 Volts

IMPORTANT: *Too high a voltage will over-charge and possibly damage the battery. Adjust the governor only to correct the dc voltage output of the generator at operating temperature. If a carburetor adjustment is made, check the governor adjustment also.*

Do not become alarmed if the ammeter reads 45 amperes when first starting the plant. After a few minutes the current will come down to normal as the generator warms up and the battery voltage comes up.

Consistently high charge rate (after warm up) could be due to a poor battery in the truck or running the plant too fast.

Vacu-Flo cooling and remote control starting and stopping make the plant suitable for installation in small compartments.

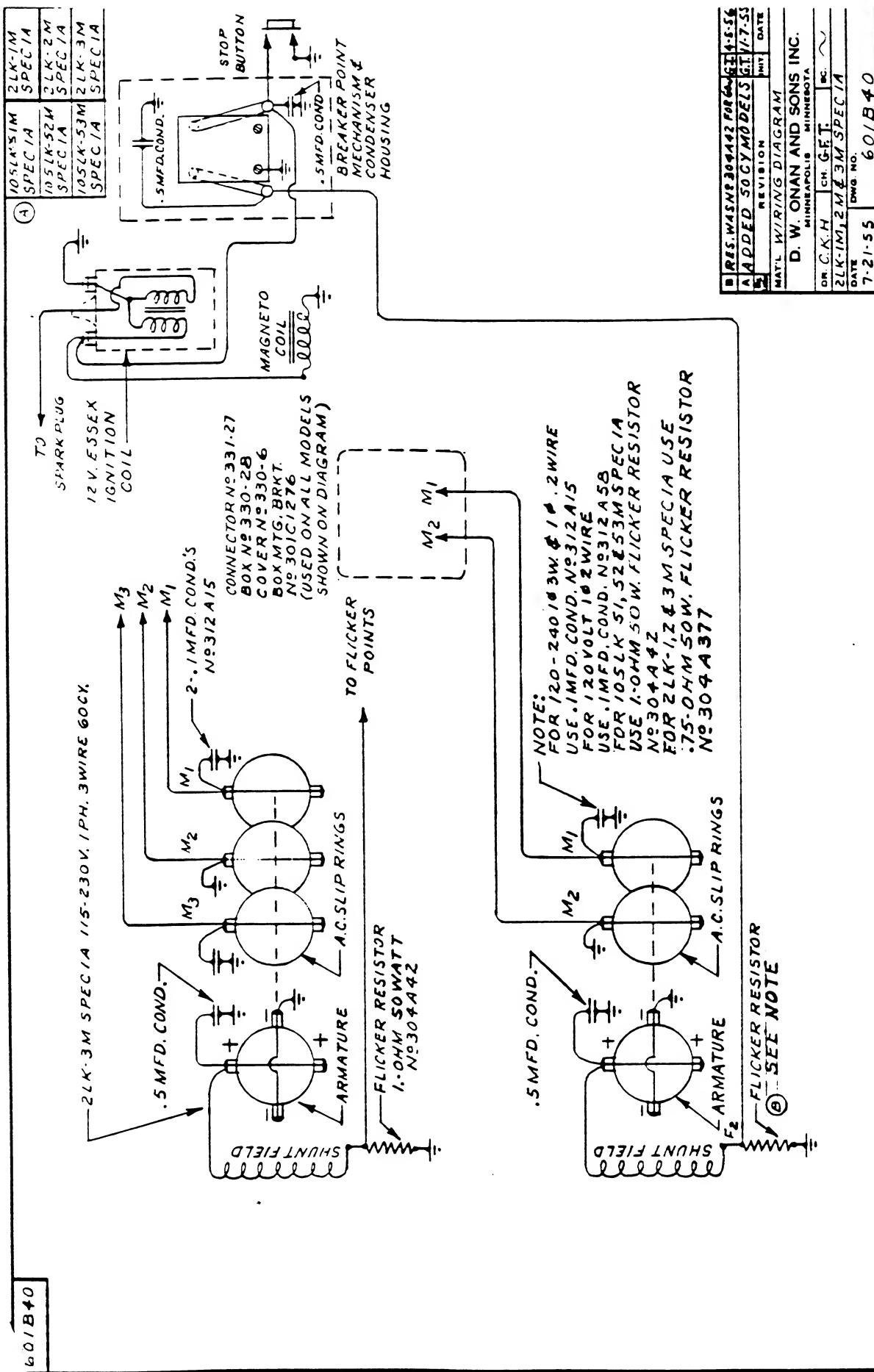
CHARGE RATE

Rated dc output is 30 amperes. A circuit breaker opens the charge circuit to protect the generator if dc output is high. Equal time is consumed by the breaker to cut-in and cut-out and it may go through this cycle several times, each succeeding cycle becoming more rapid, until it acts and sounds like a buzzer, during an over-load on the dc output. Generally, the battery will warm up and the charge rate will drop so that the breaker will not reach the buzzing stage.

As the battery reaches a charge condition, its terminal voltage approaches that of the generating plant, resulting in a desirable tapering off charge rate. After the battery becomes fully charged, the charge rate equals the dc load (radio, lights, etc.) connected.

The plant's charge ammeter reads zero while the truck's engine is running.

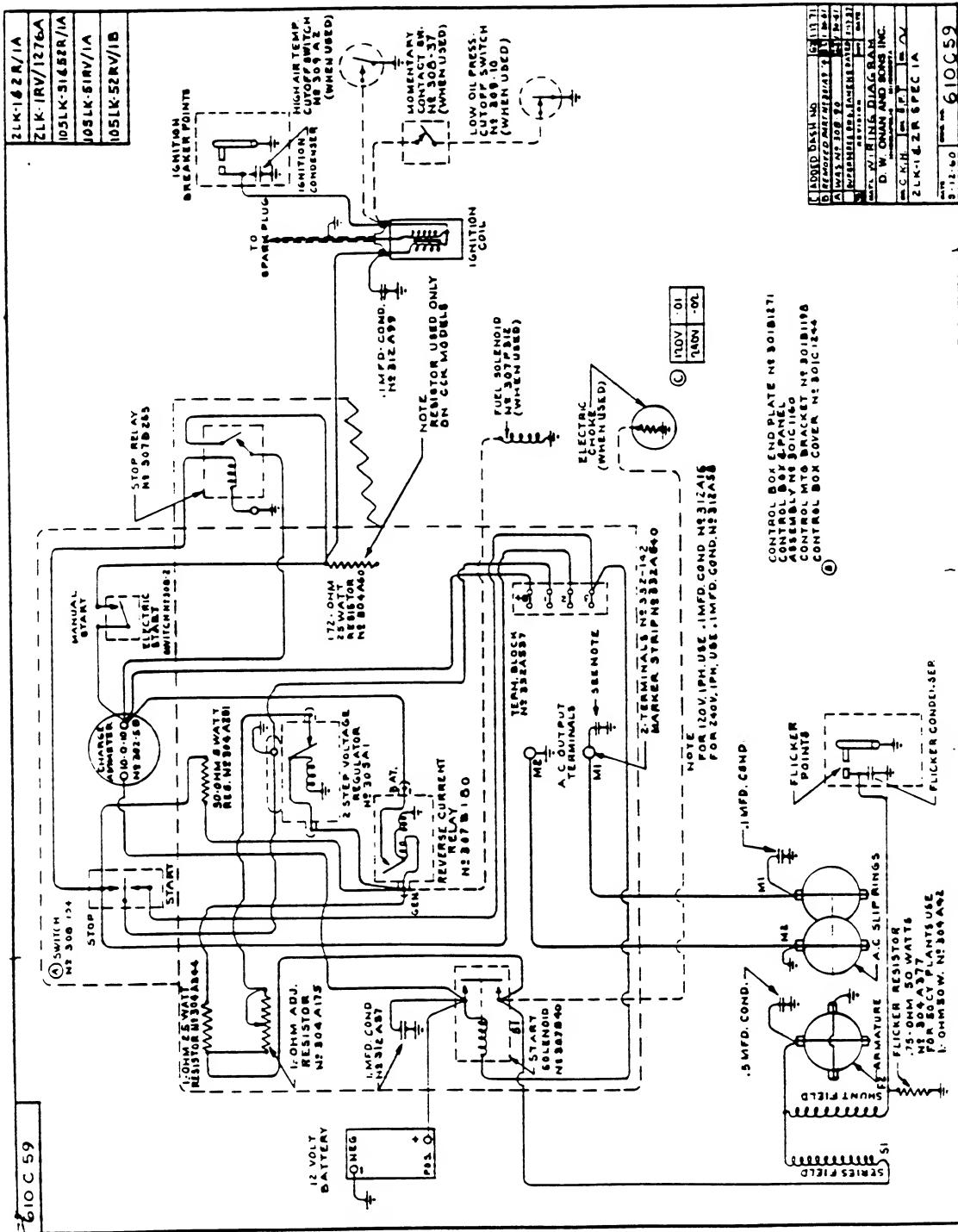
CAUTION *Begin Spec K. battery connections must be made with a NEGATIVE ground. An incorrect connection (positive ground) will cause instant damage to the diode in the battery charge circuit.*

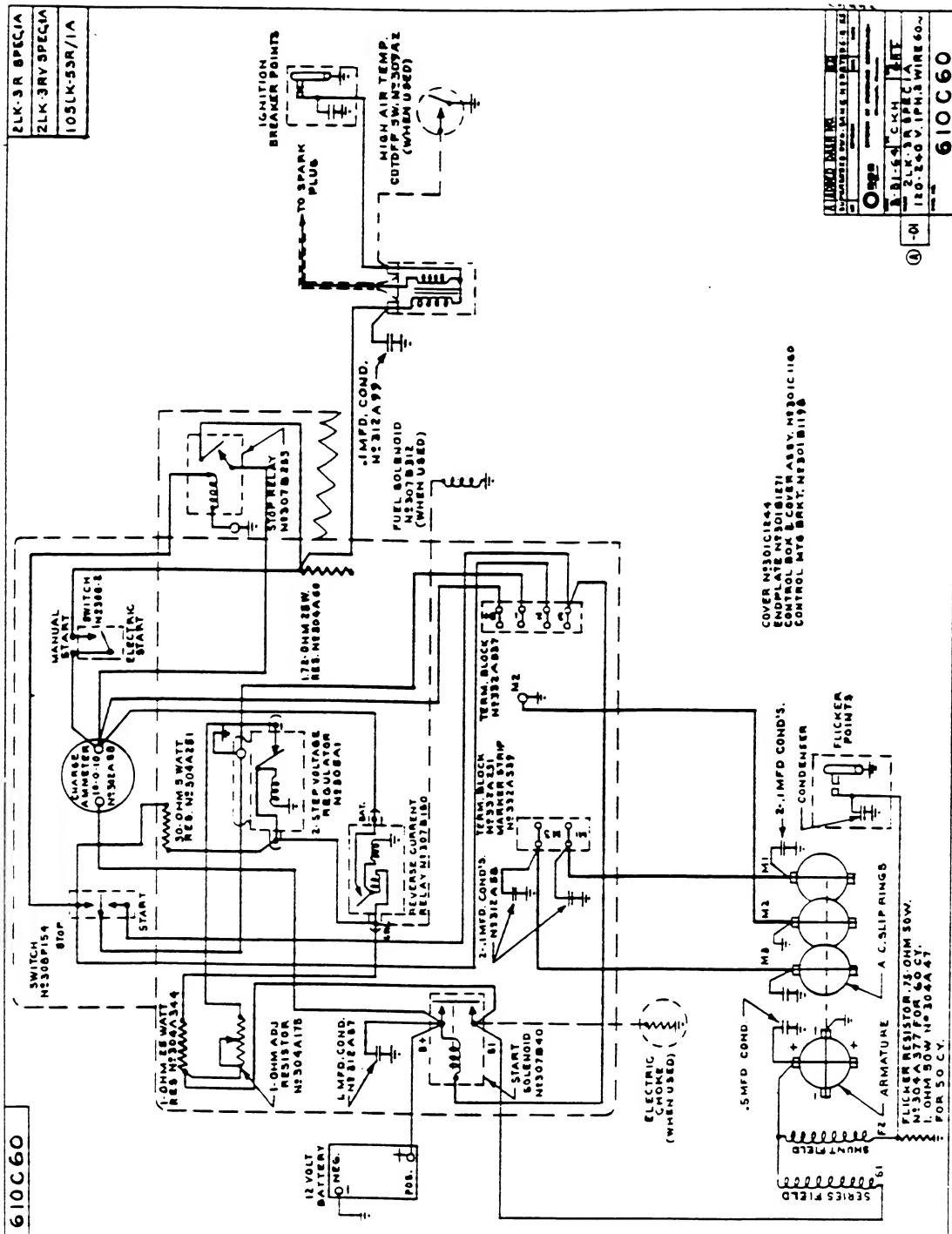


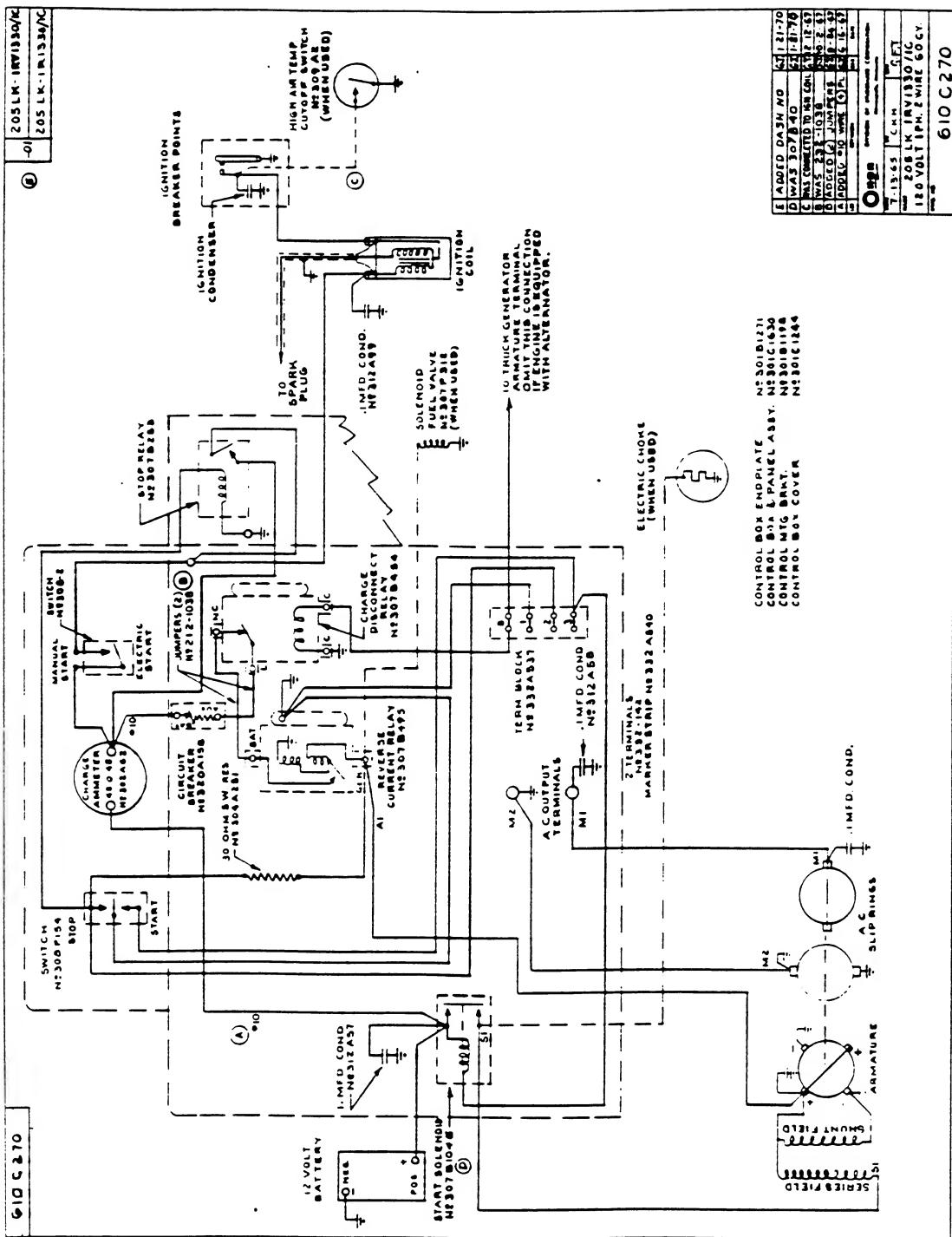
WIRING DIAGRAMS

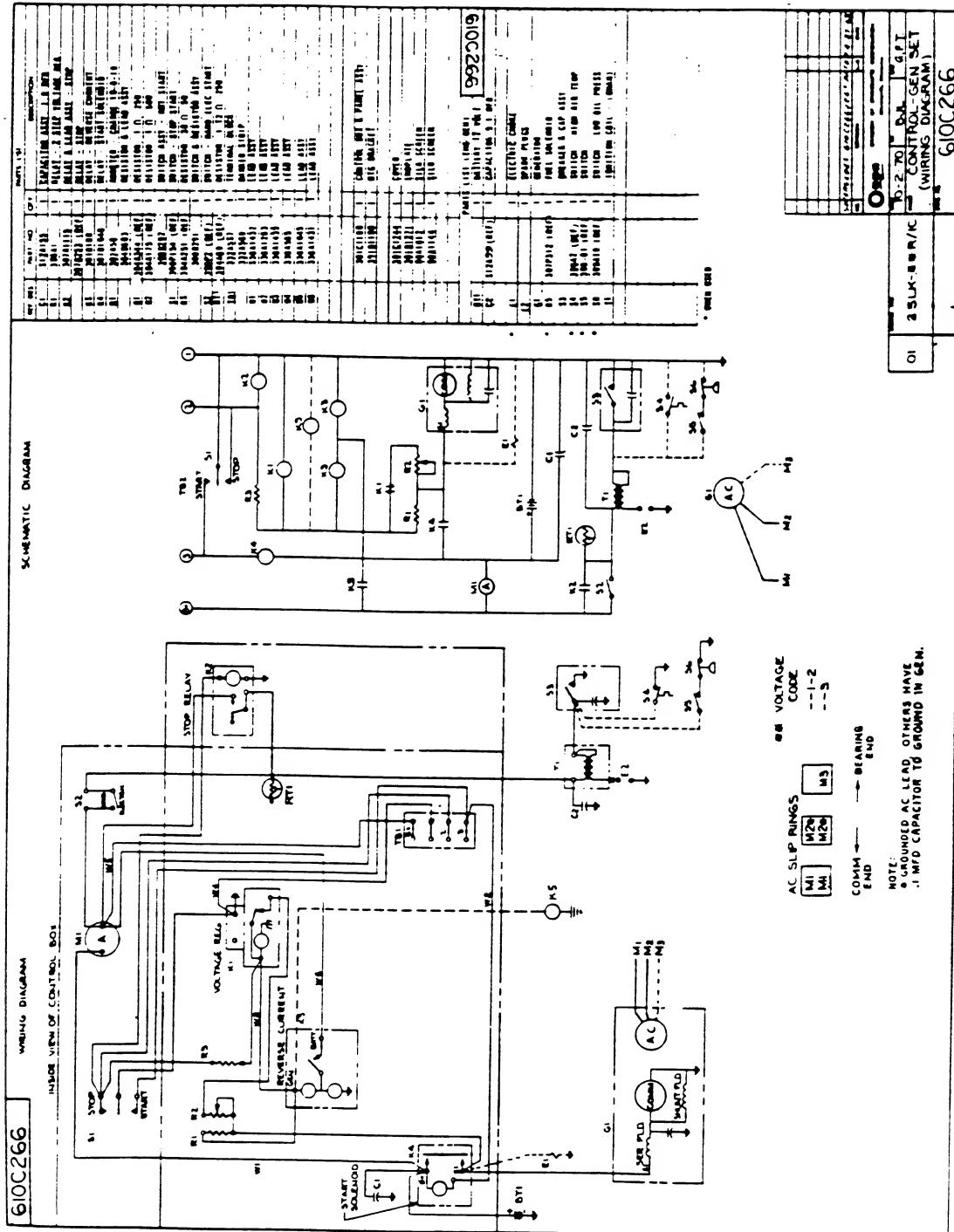
The wiring diagrams in this section are typical and apply only to standard generating plants. Wiring diagrams for special models are available on request from the factory; send generator model, spec, and serial numbers with the request.

LK SERIES						
VOLTAGE	PHASE	WIRE	STARTING	WIRING DIAGRAM	PAGE	COVERS Specs
120	1	2	MANUAL	601B40	28	A & B
120	1	2	MANUAL	601B126, 127	33	Begin Spec C
240	1	2	MANUAL	601B40	28	A & B
240	1	2	MANUAL	601B163, 164	33	Begin Spec C
120/240	1	3	MANUAL	601B40	28	A & B
120/240	1	3	MANUAL	601B128	34	C
120/240	1	3	MANUAL	601B165	35	Begin Spec D
120	1	2	REMOTE	610C59	30	A & B
120	1	2	REMOTE	610C266	31	Begin Spec C
240	1	2	REMOTE	610C59	30	A & B
240	1	2	REMOTE	610C266	31	Begin Spec C
120/240	1	3	REMOTE	610C60	29	A & B
120/240	1	3	REMOTE	610C266	31	Begin Spec C
UTILITY MODELS (2.5LK-1R/1330 or 205LK-1RV1330/)						
120	1	2	REMOTE	610C110	36	A & B
120	1	2	REMOTE	610C270	32	Begin Spec C
MOBILE MODELS (2.5LK-1R/6000 or 205LK-1RV6000/)						
120	1	2	REMOTE	610C110	36	A & B
120	1	2	REMOTE	610C266	31	C thru G
120	1	2	REMOTE	610C313	37	Begin Spec H









601 B 126	601 B 127	SPEC. C
601 B 163	601 B 164	SPEC. D and E

BOX N° 330-28
 COVER N° 330-42
 MTG. BRKT. N° 3301C1276
 CONNECTOR N° 331-27
 TERMINAL - GROMMET N° 332-142

120-VOLT
 (SPEC. C)
 2-DUPLEX
 RECEPTACLES
 N° 323 P184

240-VOLT

2-DUPLEX
 RECEPTACLES
 N° 323 - 213

TO SPARK
 PLUG

IGNITION
 BREAKER POINTS
 STOP
 BUTTON

MAGNETO

IGNITION
 BREAKER POINTS
 STOP
 BUTTON

IGNITION
 COND.

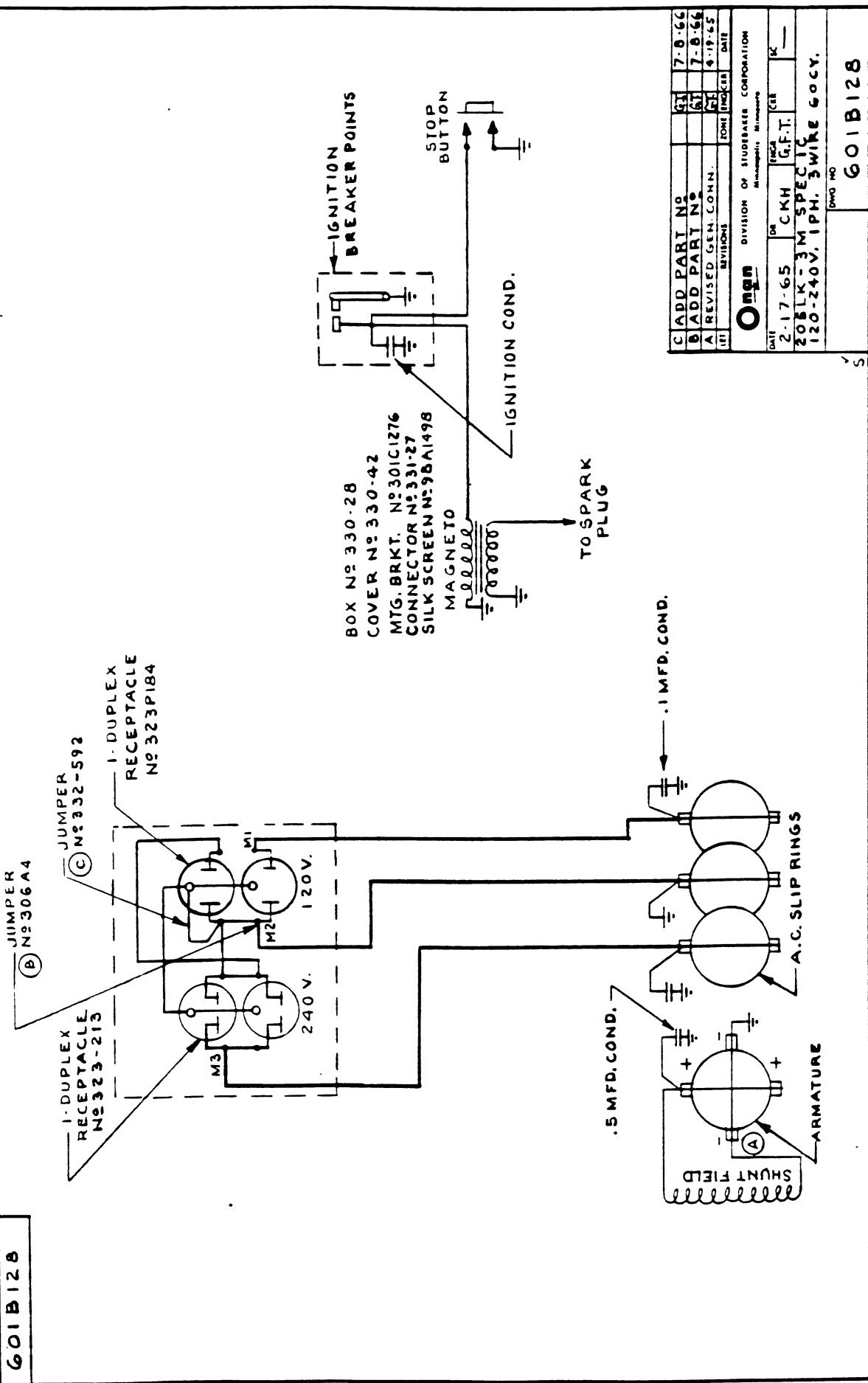
MAGNETO

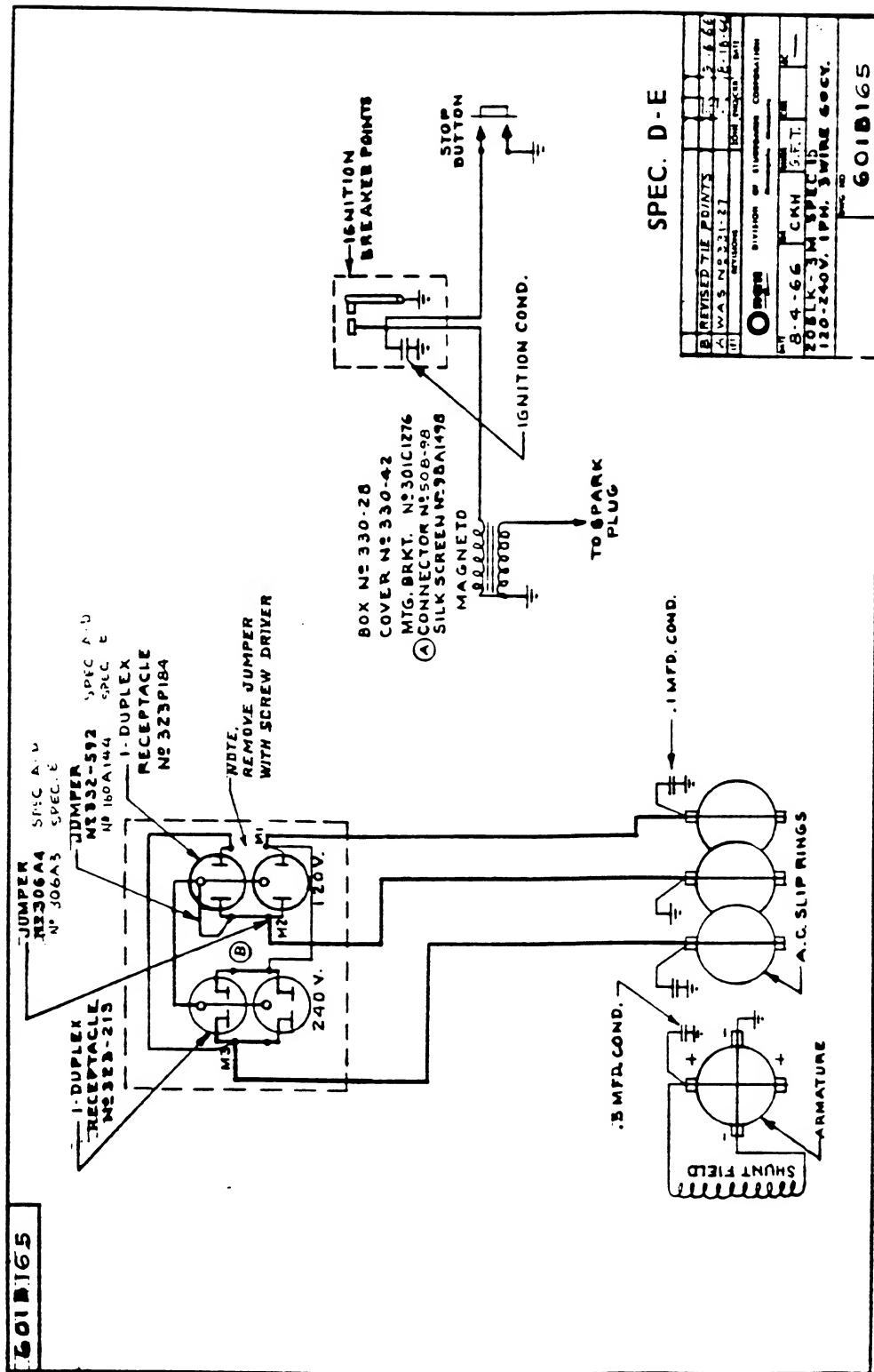
.5 MFD. COND.
 120-VOLT
 (SPEC. D)
 2-DUPLX
 RECEPTACLES
 N° 323 P184
 2. JUMPLERS
 N° 160-144
 A.C. SLIP RINGS
 ARMATURE
 SHUNT FIELD

TO SPARK
 PLUG
 120-VOLT
 (SPEC. D)

IGNITION
 COND.
 2-DUPLX
 RECEPTACLES
 N° 323 P184
 2. JUMPLERS
 N° 160-144
 205 LK- M SPECIFIC
 2 WIRE GOCY
 DMC M6

601 B-128





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